# Introduction
to
# Short wave therapy
Technique and indications

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by

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Berlin

With a Preface

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# Preface

Since the first application of high frequency currents to therapeutic practice by D'Arsonval in 1892 the development of high frequency therapy has been closely associated with that of high frequency and radio engineering technique and advances in the latter have been followed almost immediately by progress in medical application.

The early success of D'Arsonval's work with comparatively primitive methods has often been doubted but high frequency therapy obtained general recognition with the introduction of Diathermy in which the spark gap invented by Max Wien for radio telegraphic technique was applied to the generation of high frequency currents.

The latest and most important development has resulted from the application of the thermionic valve to high frequency current generation effecting a complete revolution in radio-communication technique and eliminating the spark gap previously employed. Modern radio telephony and broadcasting have in fact developed as the result of this invention.

By the use of special circuits I succeeded in 1921 in applying the thermionic valve to generation of large currents at ultra high frequencies. Low currents at these ultra high frequencies had for a long time been produced by the use of spark gaps.

The special physical effects of these large ultra high frequency currents and the distant effects of the corresponding ultra short waves produced by them suggested the advisability of investigating the possibility of their application in the field of therapy.

At my instigation, and with my close collaboration, Schliephake made the first experiments on human bodies in the electric condenser field and so laid the foundation of short wave therapy. Previous experiments with animals had shown us the possibility of biological reactions. In America also, but unknown to us, Schereschewsky had performed experiments on animals with low output short wave apparatus.

It is to Schliephake that we owe the knowledge of the important effects on the results of treatment due to the wide separation of the electrodes the body of the patient. From a physical point of view the so-called "Distance treatment" method is undoubtedly the most advantageous of all, since it solves the problem of penetrating the patient's body with a field density as homogeneous as possible, thus applying approximately the same energy density to the interior of the body as to the surface.

This distance treatment can only be obtained by the use of short waves and high outputs. The thermionic valve is greatly superior to the spark gap for both these purposes. Although this fact has been mentioned in all the relevant literature all over the world, it is still not generally known, since medical works do not always discuss the technical details in a manner which would be readily understood by a practitioner with an average knowledge of the subject.

We are therefore, indebted to the authors for having taken the trouble to present a clear picture not only of biological and therapeutic matters but also of the apparatus and technique of treatment in accord with their respective practical importance. They are the first, in the literature of this subject, to make clear by systematically arranged "field line diagrams" the process of procuring penetration of the patient in a convenient manner under the varied conditions which arise in therapy.

By this means the application of the electrodes is systematised, so that the best results may be secured, since it is only by the most convenient treatment technique, from a physical point of view, that the therapeutic possibilities of the short wave method can be fully utilised.

*Jena, September 1936*

A. Esau

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*Figures 72 to 7? and 77 to 79 are taken from the work by Schliephake mentioned on page 112*

# I. General remarks

Short wave therapy is based upon the use of high frequency currents with frequencies of from 10 to 100 million cycles per second. An antenna fed with these currents emits electric waves varying from 3 to 30 metres in length.

It is not the waves themselves propagated in space which are used for therapeutical purposes but the "short wave" high frequency currents transmitted by capacity to and within the body of the patient.

These produce immediately a definite heating effect.

It is not correct to consider short wave therapy to be an improved form of Diathermy. The biological and therapeutic effects of short wave therapy are of a completely different character and hence it must be inferred that a second characteristic specific action must be occurring in addition to the thermal action.

The indication range is considerably extended in comparison with that of Diathermy (nowadays usually termed Long wave Diathermy). It embraces in particular diseases which are contra-indicated in the case of diathermy treatment proper. Especially in ailments of this kind (acute inflammatory, purulent or septic processes) have the most favourable results been obtained with short wave therapy. As a consequence short wave therapy to-day ranks first among electro-physical healing methods, a fact confirmed by the daily increase in the short wave apparatus put into use and the large output of detailed literature concerned with the field of Science. To become acquainted with the literature of this subject is very difficult for a practitioner with limited time and effort owing to the fact that on the one hand many valuable articles are distributed in various scientific periodicals and on the other hand many author

specially recommend definite methods of applying short waves (with spark gap or valve equipment) which in the case of other writers are recommended only for a limited range of application

In general, it will be found in practice that the end desired may be attained by different methods which have not the same value from a therapeutical standpoint It is therefore desirable to determine the best method for individual cases

This book is intended to give the practitioner an introduction to the field of Short Wave Therapy, based upon sound theoretical foundations and practical experiences, and to act as a guide to the correct methods of obtaining therapeutic success in the most rapid and certain manner

For this purpose the physical principles underlying procedure and the technical apparatus used in short wave therapy (1) will be first discussed as well as the main points which are essential for the correct determination of the therapeutic qualities of the apparatus by the practitioner

This will be followed by detailed fundamental explanation of the treatment technique and the special biological effects of short waves as compared with those produced by long wave diathermy and by an account of practical experience and approved treatment methods for various diseases We attach the highest value to the explanations and figures illustrating the most convenient electrode technique in individual cases since in the literature hitherto available no exhaustive descriptions of this matter are given which would meet the needs of a practitioner, although they are of paramount practical importance

The reading of this introduction does not render superfluous the study of more detailed works (1) and this is recommended as an aid to further development and knowledge particularly if scientific as well as practical information is required To thi end we draw attention to the following books, particularly that by Schliephake the meritorious founder of short wave therapy, who deals with the subject in a very broad scientific manner

(1) A greater knowledge of Physics is assumed than that corresponding to the cu ulum of medical students in Universities

Detailed textbooks

E. Schliephake Kurzwellentherapie (Short Wave Therapy) 2nd edition Jena 1936 Publisher Gustav Fischer

E. Liebesny Kurz und Ultrakurzwellen (Short and Ultra Short Waves) Berlin and Vienna 1935 Publishers Urban & Schwarzenberg

W. Holzer and E. Weißenberg Grundriß der Kurzwellentherapie (Foundations of Short Wave Therapy) Vienna 1935 Publisher Wilhelm Maudrich

## II Physical principles.

The high frequency (short wave) currents used in short wave therapy are applied to the body not by means of bare contact electrodes as in the case of long wave diathermy but with the aid of a short wave condenser field

The patient is placed between the plates of a condenser connected to the short wave oscillatory circuit (Fig 1)

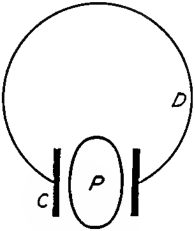



Fig 1

Patient P between the condenser plates (condenser electrodes) of a short wave oscillatory circuit, an essential part of all short wave apparatus.

The high frequency (short wave) current flows through the conductor D and generates between the condenser plates C the short wave condenser field which passes through and warms the patient.

The rigid or pliable condenser plates forming the electrodes are insulated and arranged far from the patient's body so that there is a certain distance between them. The insulating layers and these distances prevent the direct passage of current between the plates but permit the "field" to pass producing a remote action between the two plates

In this way the electric field penetrates the body of the patient acting on the ions and electrons in the body material bringing them into [illegible] oscillation, that is to say producing currents of the same [illegible] within the body

Owing to the high frequency of these oscillations the currents produced give rise to no electrolytic nor faradic effects but merely produce Joulean heat. The lines of current and heating effects are distributed more uniformly with short wave therapy than with long wave diathermy, owing to the altered physical characteristic to be discussed more fully later. The heat generated in the skin is decreased, while on the other hand, the depth effect increases. Particularly those organs which could not be heated sufficiently hitherto owing to their being surrounded and screened by fat and bone masses are penetrated and heated effectively in the short wave field.

The specific biological effects produced by short waves in addition to the purely thermal effects are probably due partly to temperature differences arising between certain very small particles of tissue (hence also a secondary thermal effect), and partly to action of a purely electric character.

Generally speaking the thermal and specific effects increase both in their intensity and healing effect in proportion to a reduction in the wavelength. Last but not least, to obtain the best possible therapeutic effect certain fundamental physical facts must be fully understood and we now proceed to discuss them.

## I. The condenser field

**The condenser in an alternating current circuit.** Two plate-shaped electrodes placed opposite to one another and charged electrically by means of a current generator form an electric condenser. When charging is carried out by means of an A.C. generator (high frequency generator) with a frequency or wavelength which can be varied to any value, the charging current increases proportionally with the frequency or in inverse proportion to the wavelength, provided that the quantity of electrical energy is the same for each current impulse transmitted.

This can be checked by an ammeter connected to the circuit. Consequently the higher the number of the impulses per second, that is to say, the periods per second, the greater the quantities of electrical energy produced which flow to and fro in the conductor uniting the current generator with both the plates forming in this manner the electric current".

This electric current is so to speak continued in the non conductive medium existing between the plates, air for instance, by means of the electrical forces, which emanate from the electrons collected upon the plate originating a remote action of the electric current and so passes through the medium "capacitatively" Thus 1 termed The current flowing through the condenser, although

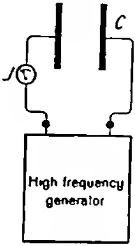



Fig 2
High frequency generator of variable frequencies (wave lengths) with ammeter J and plate condenser C connected to the circuit The ammeter J indicates an increase of the condenser plate charging current which is proportional to the increase of the number of periods (decrease of the wave length), provided that the quantity of the electric force conducted to the plates with each current impulse remains constant.

there are only electrical forces free from electrons which penetrate the so-called dielectric i e the medium impervious for the electron This apparent current is also called capacity current in contra distinction to the conduction current or ordinary electrical current for it is proportional to the capacity of the condenser the other conditions being the same

The designation electrostatic flux" is also frequently used, as this phenomenon appears within the non-conductive media only in the form of an electrostatic displacement of the electron inside the molecules as distinct from the electron transmission from one molecule to another which occurs in conductive media.

The permeability of the condenser as regard the capacitative current or in other terms the electric field force 1 designed

capacitative conductivity" and the corresponding resistance capacitative resistance.

When a so-called "bad" dielectrical medium is put between the condenser plates which possesses to a certain degree an ohmic conductivity or "current resistance", and thus conducts the electrons the electric field forces will produce currents flowing in this medium and generating in such a manner a J o u l e a n heating effect. In this case conduction will be produced within the dielectric together with the capacitative current.

**Distribution of the electric field forces in the condenser field. Hertzian waves.** The total effect of the electric forces existing between the plates or the space they pass through is termed the electric field or "the condenser field".

Provided the electric energy between the plates or within the patient be not transformed to heat, this condenser field becomes the starting point (wave centre) of a Hertzian wave radiation, penetrating into space in which it is spread i n a l l d i r e c t i o n s like water and acoustical waves. Therefore owing to the high frequency of the currents producing the field, the apparatus used in short wave therapy would generate Hertzian short waves the length of which should be equal to the speed of light (300 000 km/sec.) divided by the frequency prevailing in each case. Owing to this phenomenom the terms "high frequency" or "short wave" field have been chosen.

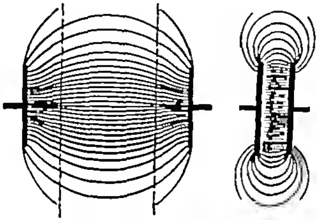
The more short waved the field, the greater is the number of the current impulses flowing through the condenser per second, and the greater is the intensity of the current; therefore the production of powerful physical or biological reactions is highly facilitated by the generation of the short wave condenser field.

The electric field forces are not uniformly distributed between the condenser plates. Field line figures illustrate the distribution obtained in the air or any other h o m o g e n e o u s medium (see Fig. 3a and b). The lines (Fig. 3a, 3b) show the direction of these forces and also that of the l i n e s o f c u r r e n t flow generated within the field when a c o n d u c t i v e homogeneous medium is used. The density of the lines supplies a measure of the electric field forces acting on the different parts which determine the intensity of the local energy and heating effect associated with these individual points of the penetrated medium.

The heat quantity produced is proportional to the square of the electric field strength, so that differences of

the field force on separate points cause strongly differentiated heat values

The following should be taken into consideration the field lines shown in the figure 3a are propagated in an approximately rectilinear direction only within the axial mid part of the picture Further a divergence of the energy lines, a so-called "energy spreading" is observed, which is particularly exaggerated on the limiting zones of the figure



Figs 3 a and 3 b

a) Field distribution with a large value of the ratio plate-distance/plate diameter

Owing to the spreading of the field lines the field is approximately homogeneous only in the mid part of the field localised in the figure by the dotted lines.

b) Field distribution with a small value of the ratio plate distance/plate-diameter

The field is practically homogeneous except for the spreading on the limiting zones

The amount of spreading depends upon the relation the plate distance bears to the plate surface or diameter respectively With a small proportional value the spreading likewise occurs to a small degree (see Fig 3b) Exception must be made as regards the limiting zones.

The field line figures represented in the above diagram are also approximately applicable to the conditions prevailing in the practice of therapy which means in the heterogeneous medium forming the human body provided however that very short (ultra short) waves are used a only with these wave and to a perfection which

depend upon the degree of the **shortening of the wave length** the **capacitative** and the **ohmic resistances** can be equali ed one against the other to such an extent that the body resistances become almost homogeneous Furthermore, it must be presupposed that the electrode area be smaller than the surface of the body part to be treated With inver e conditions another field di tribution is obtained as will be shown in a following chapter

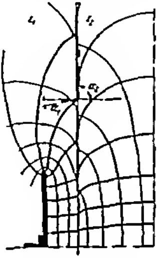


Fig 4
Refraction of the electric lines of force on the limiting urfaces of dielectric layers of different quality The figure shows the refraction obtained when pa ing through a medium of small dielectric constant (air $\varepsilon$ 1) and another of very high dielectric con tant (body ti ue $\varepsilon > 80$) There I the relation tan $\alpha$ tan $\alpha$ = $\varepsilon_1$ $\varepsilon$

If several dielectric layers of different electro-phy ical qualities (different dielectri con tant see page 1ok for in tance air and body ti ues are pa sed through within th con len er fi l L, the el ctric forc line meetin obliquely the limiting surfac will und rgo a r fraction which ob y a phy ical law (tang nt law) imilar to that exi ting in light ray refraction ( ine law) on th limiting urfa es of optical media of different d n ities But th fiel l line figure i not es entially alt red, and thi ffect i of no importance in pratice M nti n l thi i only ma l h r for c mpl t nes ( ).

**The depth effect in the condenser field Schliephake effect** Th pr nding of th field i of high importance from a practical point of view a it determine the depth effect which can be r ali ed

t I Atzol I an l R etz Der Einfluß f r El ktrod nanordnung in d r Ultrakurzw ll ntheraj i anl le Wärm v rt ilung im Körp r (The influ n e of th l tr l arrang m nt in ultra sh rt wav th rapy up n th h at li tri l uti n in th human l l k l rl fl al f exj M L V l an l C

It is evident that the low field line density existing in the central portion of the space between the plates — or in the deep parts of the medium passed through respectively — will produce a heating effect which is considerably small as compared with that originated near the surface, i e, within the region of high line density existing in the neighbourhood of the plates Owing to this, two important practical consequences should be borne in mind for obtaining good depth results

1 The dimensions of electrodes must always be as large as possible under the conditions prevailing

2 The electrodes should not be placed on the body to be treated but arranged far from it at distances of such an extent that only the central homogeneous *field zone*, as it *is limited* in Fig 9a by the dotted lines can pass through the body In other words The field zones near the electrodes, which are characterised by their increased field density, must lie outside the body to be treated in order to avoid in admissible surface heating

The importance the electrode skin distance has in practice was found empirically by Schliephake, and interpreted theoretically by Gebbert, Pätzold and Beetz. The depth effect obtainable with appropriate electrode distances is also called "Schliephake effect"

## *2 The dielectric.*

**Conception of the Dielectric.** In general layers of insulating material placed between the condenser plates are qualified a dielectric But in a wider sense this denomination is also used for medium passed through within the condenser field as for instance organic tissues, water air glass rubber and so on

The reaction of the various dielectrics is *different* as regards the permeability they *offer* to the electric force field and their respective heat capacity This is of importance in therapeutic practice as these *differences* influence to a high degree the current and heat distribution in the patient's body

**Loss free and loss producing dielectrics.** Distinction is made between two groups of dielectric i e the ideal or loss free dielectric which is not heated when penetrated by the electric field and the loss producing or "bad" dielectric which is warmed up owing to the losses of electrical energy produced by the electric

current or by the transformation of the electric energy into heat respectively It is true that this heat presents a real ad vantage in the practice of therapy for according to the knowledge we have gained hitherto about the phenomena in question, this heat is the main factor of the thera peutical effect aimed at whereby the heat distribution in the patient s body becomes of particular importance and will be described in detail hereafter in another chapter

The loss-free dielectrics are Vacuum, — air and gasses under atmo pheric or elevated pres ures and at normal temperatures

Certain artificial dielectrics especially insulating materials are almost loss free as for instance glass of a certain quality Therefore they are scarcely warmed up when penetrated

Loss-producing dielectrics are All solid and liquid substances of the human body furthermore all solutions of electrolytes colloids and leather artificial leather oil-cloth and so on

Clothe have very differentiated dielectric reaction. Mo t textures are warmed up but slightly when dry Moist stuffs (per piration) on the contrary produce always great losses and are heated up to a high degree Therefore it i indicated always to unclothe the body part to be treated when specially strong depth effects are aimed at

## 3 Heat generations in the dielectric

**The importance of the conductivity** The heat effect which i dependent on the quare of the electric field force is determined by the electric conductivity of the lo producing dielectric pa ed through for thi conductivity renders po sible the current of the electron to be generated and con equently the Joulean heat to be produced.

Anoth r form of dielectrical heating i generated by the rotation which is produced in certain electrically polari ed particles (dipoles dipole liquid ) by the electric field forces o that they rotate like a magnet needle in th magnetic alternating field From a practical point of view this heat effect i of maller importance than th Joulean effect.

**Importance of the dielectric constant.** The heating effect i furthermore dependent on the widely varying permeability which different dielectric offer to the field force The relation are

numerically expressed in the **dielectric constant**, which has unit value for vacuum, air and gas under normal pressure and temperature conditions, and is a number greater than 1 for all other dielectrics, as, for instance, for water = 81, for body liquids and tissues 80 to 90.

Hence the body substances transmit the field force lines 80 **times better** than an air space. In other words air has a capacitative resistance 80 times higher than the body substances.

**Influence of the Wave length. Selective heating effect.** Experience and experiment have shown that the wave length also operates upon the heating effect.

When several dielectrics are simultaneously penetrated by the field forces (especially solutions of electrolytes of different concentration) and the wave length is altered, not only the actual temperatures but also the relative temperatures of the individual dielectrics are altered.

**In this way for every dielectric a special wave length can be adjusted by which the heating effect is optimum** which is obtained with a determined proportional ratio of conductivity/dielectric constant.

This fact which became known by the research work of **Pätzold, Burstyn, McLennan and Burton**, and is signified by **the selective or wave length (frequency) dependent heat**" (1) is specially pronounced in electrolytes and colloids (Fig. 5) and occurs less markedly but in traceable quantities in the different body tissues (2).

For a given substance having the dielectric constant $\varepsilon$ and the conductivity $\gamma$ selective heating is obtained if $= \frac{\varepsilon}{\nu}$ wherein signifies the frequency.

In this case the ohmic conductivity is also equal to the capacitive one or in other words, the electric current has the same value as the capacitative current.

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(1) Pätzold, Die Erwärmung der Elektrolyte im hochfrequenten Kondensatorfeld und ihre Bedeutung für die Medizin (The heating of electrolytes in the high frequency field and its importance in medical practice) 36, Vol. 3, p. 85—98.

(2) Schliephake, Kurzwellentherapie (Short Wave Therapy), 1935, page 71. Ebert Kl. W. 1934 Vol 44 page 1563.

**Selective heating of very small particles. Point heating** Very small particles of a substance lying amidst media with another dielectric constant can also be warmed up selectively The expression "selectively" here only means an additional heat of these particles as compared with that of the surrounding media and has therefore a wider sense, which does not imply that the heat effect is the optimum obtainable whenever produced by the selective action of the individual frequency or wave length according to the designation given above

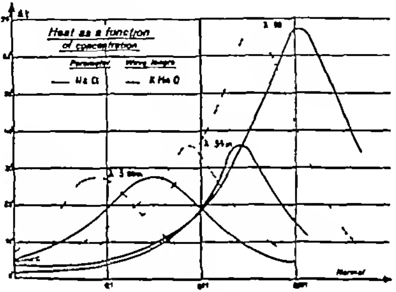


Fig 5
Selective Heating of Electrolytic Solutions
As may be seen from the curves the wave lengths necessary for obtaining the selective heat decrease with the increased concentration and conductivity of the solutions

I an first proved this by heating in the short wave field an emulsion composed of a hydrated electrolyte and oil

With temperatures of from 50 to 80 centigrade the electrolytic solution was already expelled from the oil producing scattering noise Evidently the boiling temperature of the electrolyte had already been reached whereas the oil was still relatively cool at that time The temperature of the emulsion measured at the moment proved to be the average value of the different temperatures of the electrolyte and the oil

Schliephake has proved by experiments that selective heating (in a wider sense) also occurs in very small particles of the human body. The red blood corpuscles are warmed up to a higher degree than the blood serum and certain kinds of cellule are able to reach a higher temperature than other.

Heat concentrations of such character which are manifested at points and are produced in the smallest corpuscles of the substance are examples of "Point heating" (1).

Certain specific short wave reactions as, for instance, the influence these waves have upon bacteria, at least when in vitro, are probably due to this selective heating effect or point heating.

This is also shown by an experiment made by Kowarschik (2) who placed a water receptacle with living fishes in the short wave field. The fishes, owing to overheating, died a few minutes after having been exposed to the field whereas the water did not indicate a remarkable rise of temperature.

**Voluntary Selective Influences.** Special difficulties limit the possibility of operating voluntarily on different body materials by means of this selective heating effect, as may be done with electrolytes by continuous variation of the applied wave length. In particular there are individual differences in the wave lengths producing selective effects and, in addition, the physical constants determining the selectivity are also changed in the same subject by biological processes such as changes in blood supply, conditions, alteration in structure, fat formation and so on.

*Only when it is possible to determine accurately these constants* (conductivity and dielectric constant) *before* treatment could an advantageous system of applying a selective wave length be adopted. Generally speaking this is unnecessary in practice, as successful therapeutic results obtained with fixed ultra short wave lengths already are greatly superior to those obtained by any other therapy method.

(1) The conception of "Point Heating" applied to heating dependent on wave length and originated in microscopic particles of a dielectric (cellules etc.), first appeared in an article by Patzold: Das Wellenband der selektiven Erwärmung (The wave band of selective heating). Strahlentherapie 45 (19[illegible]).

(2) Kowarschik: Über die selektive Erwärmung der Kurzwellen (The selective heating of short waves). Münch. med. Wschr. 1935, [illegible] page 11[illegible].

Nevertheless the possibility of selectively operating upon the corpuscles should be considered not only for scientific reasons, but also for special purposes lying within the working domain of hospitals and research laboratories

Therefore the **Siemens Reiniger Werke, Berlin,** have designed apart from the usual short wave apparatus with fixed wave length, the so-called Ultra Pandoros , which enables the wave lengths to be modified continuously and which will be described later

## 4 *Wave Length and Depth Effect*

**Influence of the wave length upon a medium of homogeneous layers** When a glass trough filled with minced meat is penetrated in the condenser field, thermometers being immersed at both the ends and in the centre so that it is possible to ascertain the temperature rises which take place in the interior and on the surface of the field determining in such a manner the relation of the temperature or the relative depth effect no remarkable differences are indicated when modifying the wave length

But this proportion is fundamentally changed when the thermometer in the midst of the trough is arranged in a glass bottle which is likewise filled with minced meat (Fig 6)

If then, to begin with, long wave diathermy current is led to the minced meat by means of bare electrodes no remarkable depth effect is obtained owing to the fact that the diathermy current cannot pass through the non-conductive glass of the bottle It therefore only surrounds the bottle and no heating effect is exerted upon the minced meat enclosed in the bottle neglecting the temperature rise originated by the heat conduction through the glass wall which is of smaller importance

When applying the longest short wave employed in therapy that is to say the 30 metre wave the middle thermometer also indicates a temperature rise which is originated by the heating effect of the current The temperature rise of the minced meat within the glass bottle will increase constantly when currents of continuously decreasing wave length are utilised and advance to the temperature rise obtained in the test carried out without the glass bottle when very short waves are used

The re-ults of this te t are explained by the fact that the gla s wall of the bottle, which is in contact on both side- with the minced meat form a condenser, the capacitative conductivity of which ri-e- in the degree to which the wave length becomes shortened according to the statement on page 7

Thi may be formulated as follows "The capacitative pene trative power of a wave (1) Increase as its length decreases"

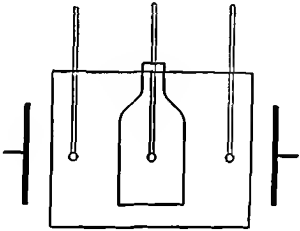

Fig 6

Glass trough with glass bottle and three thermometers within the condenser field.

The trough and the bottle are filled with minced meat The temperature rise of the thermometer placed in the bottle depends on the wave length This experiment illustrates the observation that human organs surrounded by masses of bad electric conductivity (fat and bones) can be penetrated the more intensively the more the wave length applied is shortened. This investigation may al o be carried out to advantage by employing a field probe and will be described later In this case the trough and bottle are to be filled with water

When the wave length i shortened to such an extent that the capacitive conductivity of the glass wall of the ttle is equal to the ohmic conductivity of the minced meat, th h effect m be obtained as in the experiment carried ou gla s and in thi ca e is optimum.

(1) The expres ion ich ha be fi one No wa pen trat tween th ce field charact ri ed by t employe

Hence in therapeutical practice all human organs surrounded by masses of bad ohmic conductivity i e., fat bones fascia can be penetrated the more intensively the shorter the wave length employed and generally speaking owing to the special composition of the human body which consists of several layers of well and poorly conducting substances the strongest depth effects will be

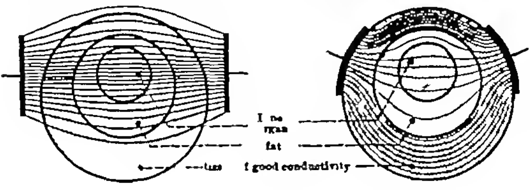


Fig 7 Fig 8

Fig 7

Field and current di tribution in short wave therapy

The capacitative resistance of the fat layer is decreased so that a relatively strong current passes through that layer and the inner organ. In order to make more evident the conditions existing the ideal fiel l structure or flow of current respectively I represented

Fig 8

Current di tribution in long wave diathermy

The current prefers the paths offering the lowest resi tance and therefore pa es through the ti ues of good conductivity The fat layer of bad conductivity allows slight traces of current only to pa s through o that there is hardly an electric influence on the inner organ, even if it i of good con luctivity (Screening effect of the fat layer "current hadow")

obtained with the shorte t waves The current condition obtainable are diagrammatically sketched in Fig 7 and 8 and make evident the difference exi ting between hort wave therapy and long wave diathermy field

At the upper part of the hort wave range near the 30 metre wave length the condition approximate to those prevailing in diathermy proper

The experiment made with the *glass bottle meat phantom* explains the fact that the resistances, or the total heating effects tend to become completely homogeneous when the wave lengths are sufficiently shortened. In practice this effect is characterised by the current paths which now do not prefer the media of smallest ohmic resistance, i. e., the larger blood vessels, as is the case in long wave diathermy, for the capacitative resistances, high as they are for the long waves used in diathermy, become equalised more and more to the lower resistance values of the blood canals by the application of short waves.

To emphasise the differences existing in the shortest and the short wave treatments respectively, the designation "Ultra short wave therapy" is sometimes used for waves under 10 metres of length and "Short wave therapy" for wave lengths over 10 metres.

**Electric Depth Effect and Thermal Depth Effect.** Generally the strongest heating effect is achieved with the shortest waves, provided that sufficient energy outputs are available for producing sufficient heat sensations. However, it is also possible that certain selective heating of the organic substances is *obtained* by the action of definite waves of greater lengths, as has been shown by the experiment made by Schliephake and Gebbert.

Therefore it is recommended to divide the conception "depth effect" into "electrical depth effect" relative to the electric force field passing through, and the true "thermal depth effect". Contrary to the electric depth effect, the thermal one is exposed to influences produced by blood circulation cooling and heat *conduction*.

**Influence of the Wave Length upon the effective Electrode-Skin Distance.** Another indirect improvement of the depth effect obtained with short waves is secured by arranging the electrodes at a large distance from the skin which is rendered possible by the intensified capacitative penetration power of the short waves in the air media. According to what is explained on page 10, these large distances even enable us to achieve the best depth effects.

To a certain degree it is possible also with *longer waves* to raise the capacitative penetration power in air layers and use larger electrode-skin distances, in such a manner improving the depth effect, when corresponding

constructive measures (increased voltages on the electrodes or the condenser plates) are employed. But, as it has been shown by the experiment on the glass bottle phantom, the depth effect realized in a stratified medium with longer waves is not equal to that obtained with shorter waves, the electrode-skin distance and the other conditions being the same in both cases (see Fig. 6, page 16.)

The depth effect therefore depends on **t w o f a c t o r s**, i.e., the electrode distance and the wave length (frequency). When the tension increases, **o n l y o n e f a c t o r** is improved, that is to say the electrode distance.

Reduced wave lengths (increased frequency) result in enlarged electrode distances and improved depth effects simultaneously.

## III. Technique of Short Wave Generation and Short Wave Therapy Apparatus.(1)

### 1 *Undamped valve oscillations damped spark gap oscillations.*

Short wave currents are produced by two methods. In the first method, which also is more general, an electronic valve connected to an electric oscillatory circuit is excited, in the second, a spark gap of the well known type, as used in long wave diathermy, serves this purpose. These methods are characterised by certain differences of their function.

Fig. 9

Undamped oscillations of an oscillatory circuit excited by the electronic valve.

The valve works in this case with constant direct anode voltage and therefore produces oscillations of constant amplitudes (unmodulated oscillations as opposed to the modulated ones which are obtained by modifying the anode voltage as with alternating voltage. (See also Fig. 15 and 16, pages 28.)

The electronic valve generates so called undamped oscillations of a strictly determined wave length (see Fig. 9). Owing to the relatively high efficiency obtained even the highest outputs which

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(1) The practitioner who is obliged to save time may in the first instance pass over the constructional details which have been given here to facilitate occasional technical investigations.

can be applied in practice are generated within the ultra short wave range in an economical manner.

As opposed to the electronic valve the spark gap supplies damped oscillation of non homogeneous (heterogeneous) wave length (Fig. 10). Upon a predominant wave length is superimposed a mixture of several different wave lengths (we shall deal with this matter in detail under Chapter IV). High outputs as required for diathermy can be obtained within the long wave range (300 to 600 metres) in a simple manner by means of the spark gap but in the short wave range of from 3 to 30 metres considerably reduced

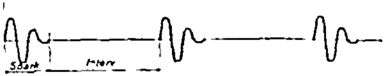


Fig. 10

Damped oscillation in an oscillatory circuit excited with the spark gap

The damped oscillation produced by spark gap are characterised by their high initial amplitude, their rapid decrease and final decay (breaking of the spark) as well as by the relatively long interval between the succeeding oscillating spark discharges.

output only will be achieved owing to the relatively unfavourable efficiency of the spark gap when it is desired to keep the apparatus price within reasonable limits from an economical point of view.

The efficiency of the oscillation generating process always decreases when the waves produced are shortened. Indeed the law is generally valid for the spark gap service and, therefore, the output obtainable with spark gap in short wave therapy only amount to a fraction of that realised with the electronic valve when for reason of instituting a correct comparison approximately the same apparatus price and the same wave length are considered.

In Germany both methods of oscillation production are used in the construction of short wave apparatus, the application range of which in therapy is primarily determined by the different output and wave length they supply.

It is true that abroad the spark-gap is scarcely used *for short wave* generation, electronic valves being employed *for this purpose almost* exclusively as its general application in these countries is *not restricted by* patent rights as in Germany

**The electronic valve** Valuable research work has been done by the Siemens Reiniger Werke in the construction of the first short wave therapy apparatus produced in Germany This *apparatus* was *equipped* with the same types of valve which are generally used in the wireless transmission. As short wave therapy strains the tube material to a higher extent than wireless technique certain service intervals of rest have been prescribed for cooling purposes after periods of 10 to 20 minutes of treatment with these valves

To-day, on the contrary, the S W R (1) employs special valve for medical purposes, which are characterised by their highly in creased thermal capacity and, therefore, allow a totally unrestricted treatment time No technical difficulties have arisen, for instance, in an uninterrupted service (2) of 10 hours applied to different patient

Progressive efficiency reduction due to diminution of emission, which often happens with broadcast receiving valves equipped with oxydized hot cathodes owing to the slow evaporation of their oxide coating, is totally eliminated with these valves as their hot cathode consists of pure tungsten without additions liable to vaporation

The use of these valves in therapeutical practice is therefore not restricted as regards the operating time, and to-day they provide a service duration amounting normally to 1000 up to 3000 service hours reaching at times even 4000 hours Generally speaking service economy depends on the guaranteed working duration, and the efficiency of the apparatus and its economical service are chiefly dependent upon the technical perfection of the dependent valve

The Siemens valves employed to-day are represented in figures 11 and 12 Fig 11 illustrates the concentric arrangement of the three electrodes The anode is of a cylindrical shape and form

(1) S R W — Siemens Reiniger Werke Berlin.

(2) ... Anzeigestellungen und Ergebnisse der Kurzwellenbehandlung in der ... (Indications and results of short wave treatment in therapy) M. m ... 1934 Vol. 1...

the casing Inside the casing the grid is placed which projects at the upper end inside the grid is mounted the hot cathode formed by several stretched tungsten wires

The water-cooled valve type (Fig 12) of the fever therapy apparatus Pyrotherm constructed by S R W., which will be

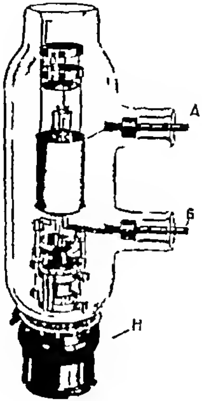


Fig 11

GRI Electronic Valve of Siemens and Halske Berlin.

The valve has been designed especially for producing short and ultra short waves for therapeutical purposes and is employed with the S R W short wave apparatus

A = connecting pin for the anode
C = connecting pin for the grid
H = Heater connecting plug inside the base

described in detail later has the same electrode arrangement but is characterised by the special shape of the hot cathode which takes the form of a cylindrical copper vessel hermetically sealed to the glass bulb The cooling is effected by means of a removable receptacle

through which the water flows, surrounding concentrically the hot cathode. The water cooling enables the valve to produce particularly high oscillation outputs.

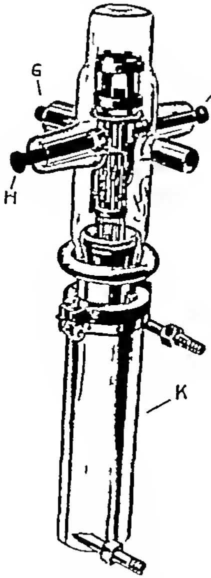


Fig. 12.

Water cooled electronic valve of Siemens and Halske Berlin. The valve serves for transmission as well as for therapeutical purposes and renders possible short waves of especially high output to [illegible]. It is employed in the fever therapy apparatus Pyrotherm.

H Heater connecting plug inside the base.
G connecting pin for the grid.
K removable anode cooling vessel.

## 2 The valve equipped apparatus

a. **The Primary Circuit.** The diagram shown in Fig 13 illustrates the working principle and the operation of a valve equipped apparatus I shows the transmitter primary system and II the receiver secondary system (the patients circuit) (1)

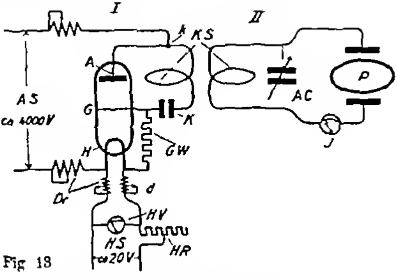


Fig 13

Circuit diagram of a short wave apparatus provided with Esau circuit for generating ultra short waves

I – Primary System (Transmitter)
II — Secondary System (Receiver)
A — anode
G = grid
H = heater
HS – heater voltage
AS = anode voltage
Dr = choke coils in the heater and anode current conductors
d = bridge for tuning the choke coils
HV = voltmeter for the heater current,
HR = heater regulating resistance (variable resistance)
GW = grid resistance
K = fixed condenser
k = connection point of the anode current at a voltage node of the oscillatory circuit
KS = coupling coils (working principle of a transmitting and a receiving aerial)
P = Patient between the condenser electrodes
J = indicating instrument (thermo electrical ammeter) for tuning purposes
AC = tuning condenser (variable condenser)

(1) Literatur Bergmann, Versuche mit hochfrequenten ungedämpften elektrischen Schwingungen (Experiments with high frequency undamped electric oscillations). Berlin and Rome Publisher Dümmler

An anode voltage of 4000 volts exists between the hot cathode H and the anode A, which causes the electrons emitted by the hot cathode to fly with a velocity of 1/100 of the speed of light to the anode traversing the grid, thus continuing in this manner the anode current of the anode circuit

When a voltage of negative character as regards that existing on the hot cathode is applied to the grid, the passage of the negative electrons is obstructed and the electron flow consequently weakened On the other hand, the electron flow is reinforced with a positively charged grid

Hence the electron flow can be regulated by means of a high frequency alternating voltage impressed on the grid in such a manner that only high frequency impulses pass through the valve These impulses excite an oscillatory circuit connected to the valve in an Esau" circuit setting up a continuous oscillation.

It would be possible to use a special small oscillator for producing the regulating high frequency alternating voltage (separate excitation) But it is more convenient to work with self excitation in such a way that the grid itself is rigidly connected to the oscillatory circuit and thus is self-oscillating The grid forms a condenser together with the anode (internal capacity of the tube) and in conjunction with the fixed condenser K constitute the capacity (C) of the oscillatory circuit The fixed condenser serves the purpose restricting the anode tension against the grid and the grid resistance in such a way compelling the anode current to flow through the valve passing the anode A and not across the grid. The left hand coupling coil KG and the connections constitute the self induction (L) of the primary oscillatory circuit The product $C \times L$ determine directly the wave length ($\lambda$) produced or the periodic time (T) proportional to it. According to the formula of Thomson, $T = 2\pi\sqrt{CL}$, so the periodic time decreases in the proportion in which the product $C \times L$ is reduced

The grid resistance GW serves the purpose of keeping to a fixed average value the potential of the grid (voltage existing between the grid and the hot cathode) which affect the efficiency of the oscillation generation

Choke coil Dr prevent the oscillation produced from wandering off which would result in an energy deviation via the

wire connecting up the anode and the heating current source. The winding of the coil are adjusted to the optimum value which depend on the wave length, by the aid of the bridge d.

As regard it frequency determined by capacity and self induction, the oscillatory circuit may be compared with a tuning fork the tone frequency of which is characterised by its mass and elasticity. When the tuning fork is excited by means of an electro magnet (Fig. 14) which is put in operation by means of a contact fitted to the tuning fork with a connection like that existing in the trembler bell, this contact fulfils the function of the grid, which oscillates electrically with the oscillatory circuit. The contact adjusting screw J may be compared with the grid resistance GW.

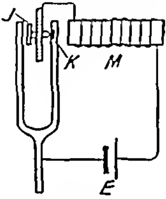


Fig. 14

Tuning fork excited by an electro magnet

E galvanic battery
M electro magnet
K contact
J adjusting screw of the contact

The electromagnetically excited periodical oscillation of the tuning fork may be compared with the u n d a m p e d e l e c t r i c a l o s c i l l a t i o n produced by the electronic valve.

A. C. (alternating current) transformer are used for supplying the current necessary for the hot cathode and the anode. The A. C. transformer is the most simple and at the same time the most convenient current source.

The anode voltage is not variable in the apparatus described above. The heater voltage of the hot cathode can be modified by means of the heating regulator HR for adjusting the dosage rate to be applied. Adjusting the heater voltage enables a practically regular variation of the output to be carried out and at the same time spare the hot cathode or the valve respectively in the best

possible manner, as the filament is heated in every case strictly to that degree which corresponds to the required short wave dosage

The working principle of the electronic valve implies the fact that only one half wave of an oscillation of the low frequency alternating mains current is used for producing the oscillation, as the

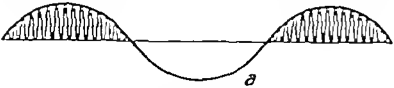


Fig 15.

Curve of the *oscillations produced by a valve equipped short wave* apparatus working with half wave operation.

U n d a m p e d o s c i l l a t i o n s are generated (see Fig 9), but they are modulated at the frequency of the main The curve a shows the sine form of the mains voltage The interval in the oscillations is due to the fact that one half wave of the mains voltage is not used for generating the oscillations Indeed this deficiency of one half wave does not result in a disadvantage such as for instance decrease of efficiency Also in half wave operation e s s e n t i a l l y h i g h e r o s c i l l a t i o n o u t p u t s (w a t t s) can be obtained with the electronic valves than with the spark gap

Fig. 16.

Curve of the oscillations with full wave operation.

This kind of operation, suitable for producing extra high outputs *1000 to 1500 Watts for instance is employed in the (highly efficient)* short wave fever therapy carried out with distance electrodes The full wave operation is utilized in the fever therapy apparatu P y r o t h e r m.

electronic valve only allows the current to pass through if the current source pole connected to the cathode is negative (Half wave operation. See Fig 15)

It is possible to employ both the half waves of a period for the production of [illegible] oscillation when special circuits are applied (Two incandescent [illegible] in [illegible] circuit, i.e., the Wehnelt circuit, or two electronic valves in push pull connection Full wave operation, see Fig 16). But with the oscillation [illegible] are concerned this would not offer any advantage and on the [illegible] it unnecessarily complicates the design of the apparatus and

increases its price Only for producing **extra high outputs** generated for instance by the water-cooled tube of the fever therapy apparatus **Pyrotherm**, full wave operation is justified from a technical point of view

b **The secondary circuit (patient s circuit)** Transmi ion of the short wave oscillation to the patient i carried out by coupling inductively by means of two coupling coils KS the primary sy tem I to the secondary system II.

System II also constitutes an oscillatory circuit and mu t be tuned accordingly so as to be able to take maximum energy from the primary The tuning principle i the same a in the case of tuning broadcasting receivers to the tran mitting station.

For this purpose a variable conden er i connected to the circuit in parallel with the patient (lo s-free tuning condenser AC) which add to the capacitative value of the patient him-elf the electrode area and distance giving an additional capacity of such a value that the resulting total capacity reache ju t the amount required for correct tuning

A current mea uring in trument I (current indicator) connected to the secondary indicate the most favourable adjustment of the variable condenser which i obtained when the pointer deflection i a maximum

Both in the primary and secondary the product capacity × self induction are of equal value when correct tuning is achieved that is to say **electrical re onance** i obtained which may be compared with the **acou tical resonance** of two tuning forks A is well known a tuning fork can excit another placed close by to corre-ponding oscillation only un l r such circum tances that both the tone frequencies or the corresponding t ne wa e length are of the ame value

The current indicator mea uring the tuning effect i not subjected to high frequency current but connected to the direct current produced by a thermoelement which i pa ed through and heated by mean of the high frequency current (thermo-converter)

The current indicator imultaneou ly serve the purpose of controlling the a lju ted do age (but doe not mea ure the dosage) The pointer deflection upon the cale obtained in each case indicate clearly the alteration which cannot be recogni ed by auxiliary in trument of impler design ( mall incande-cent lamps or vacuum tubes)

c. **Constructive design of the valve equipped apparatus. Technical safety devices.** The internal parts of a valve equipped apparatus of the S R W (Ultratherm) are arranged as shown in Fig 17. Fig 18 illustrates the apparatus ready for use and Fig 19 the switch panel of the apparatus.

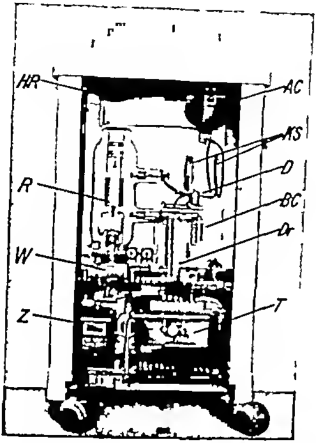


Fig 17

The Ultratherm (interior view)

Valve equipped apparatus for waves of 6 metre length with a net therapy output of about 300 Watts.

T = high tension transformer
R = valve
W = series resistance for protecting the valve against overheating
BC = coupling coils
D = distance plate (prevents the contact of the two coils)
AC = tuning condenser
HR = heat regulation resistance (variable resistance)
Z = hour counter

The terminal strip shown on the transformer above enables every usual mains or transformer voltage to be connected to the apparatus. No parts needing special care, attention or adjustment are incorporated.

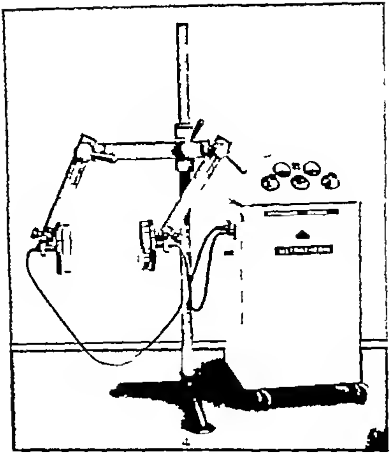

Fig 18

The Ultratherm with adjustable wooden upright stand for fixing the Schliephake electrodes

The upright stand renders possible penetration with electrodes arranged in the most varied manner applied to patients in a sitting or recumbent position, and also in a vertical direction across the patient underlayer

Holders fitted to the apparatus can be used instead of the upright stand (see Fig 20) The apparatus is also used to advantage for electro surgical operations (cauterisation and coagulation) of less importance

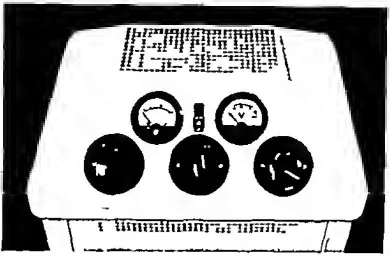

Fig 10

Switchboard with instruments and handles marked with their respective designations. A = current indicator V = voltmeter for the tube heater current. The switch placed between the measuring instruments serves for changing-over the two ranges of the current indicator

Figures 20 and 21 illustrate two other types of apparatus, the Radiotherm and the Ultra Pandoros, which generate several wave lengths The fever therapy apparatus Pyrotherm, represented in *Fig 22, comprises an installation for short wave fever therapy* (Electropyrexia) The water cooled valve of the Pyrotherm (Fig 12 page 24 works with rectified anode voltage (Fig 16 page 28) in a Grätz circuit The Pyrotherm has a therapeutical output of about 1000 Watts with a wave length of 12 metres This high output renders possible large electrode skin distances to be applied which are necessary for avoiding local overheatings

Special attention should be paid to the precautions in construction which are important for the safety of the patient and enable safe work to be done with the short wave apparatus No galvanic connection exists *between the* high voltage primary circuit and the secondary or patient s circuit For instance in the Ultratherm ( ee Fig 17 page 30) the coupling coils are placed at uch a di tance one from another (and locked in their respective ions by mean of uitable devices) that movements of an ex ent which would cau e short circuit are practically speaking totally eliminated Constructional mea ures of thi or of a similar kind protect agaln t danger from low frequency or high voltage circuits even in cases of lo nlation

faults in the electrode cables and electrodes mechanical damage and accidental touching of bare metal parts In such a case the person touching these parts would merely be traversed by the high frequency

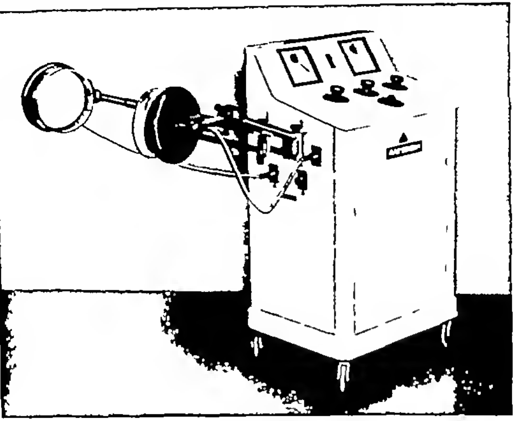

Fig 20
Siemens Radiotherm with electrode holders and electrodes
Valve apparatus adjustable to two wave lengths viz. to the 6 metres wave with a net therapeutical output of about 300 Watts and to the 12 metres wave with a net therapeutical output of about 300 Watts The holders can be removed by a single operation and used for other therapy apparatus With the apparatus not in use the holders should be turned upward to save space
The apparatus is also suitable for carrying out electro surgical work (cautery and coagulation) as well as light fever therapy

current which is without faradic stimulus and would induce localised burning only like those caused by the diathermy current

Although insulation faults are almost totally eliminated provided that the apparatus is suitably operated complete safety against contact with the dangerous low frequency current is necessary

nevertheless, as bare electrodes are used with the apparatus for surgical purposes (cauterisation and coagulation) and, sometimes, for treatments of body cavities

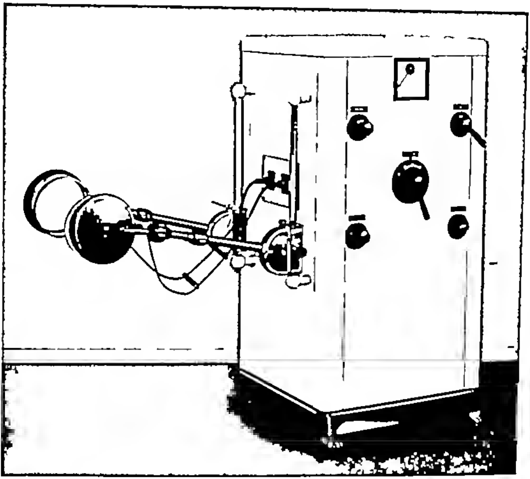

Fig 21
The Ultra Pandoros (S.R.W.)
Valve equipped apparatus with two GRI valves in push pull circuit on the high frequency side
The wave length is adjustable to any degree within the limits of from about 3 to 8 metres
Net therapy output with 3 metre wave approx. 350 W
„ „ „ „ 4 „ „ „ 530 „
„ „ „ „ 8 „ „ „ 630 „

The apparatus cabinet is earthed for preventing dangers which would otherwise arise when the low frequency current makes contact with the cabinet owing to unsuitable operations carried out in the interior of the apparatus

localised mains conditions, are conducted to the mains. Then it will almost be sufficient to use the simplest models of the usual interference eliminators (small condensers with *earthed* centre-point connected in parallel to the mains leads).

In complicated cases a combination of choke coils and condensers must be fitted to the leads connecting the short wave apparatus with the main. Often reliable results are achieved by suitable operations carried out on the disturbed receiver apparatus (changing of position, screening and shortening of the aerial and the earth connection, connecting a condenser in the aerial, screening the receiver, connecting a choke-coil condenser combination to the mains connection or choke circuits to the mains connection, aerial and earth lead). Earth lead and aerial must be placed as far as possible from the electric conductors and the valve connections and arranged in such a manner that they are not running in parallel to the aerial or the earth connection respectively. The screening devices of the receivers, the earth connection and the aerial are to be joined conductively one to another and connected to earth.

Only when the receiver installation is modern in character and equipment can the user expect an undisturbed broadcast service from the most powerful regional transmitter.

## 3. The spark-gap apparatus

The fundamental design of a spark gap equipped apparatus (1) is very similar to that used in long wave diathermy. A primary oscillation circuit which is excited by spark gaps, transmits its oscillation energy by capacitative and inductive couplings to a secondary oscillatory circuit (Fig. 29). Short waves, however, require the oscillatory circuit to be dimensioned in a radically different manner from an electrical point of view. The capacity and the self induction must be essentially smaller than the respective values in long wave circuits. Besides, there are fundamental differences as regards the resonance tuning between spark gap and valve equipped apparatus owing to the varied physical conditions.

Contrary to the case of the valve equipped apparatus in which the secondary circuit is tuned to a primary producing a rigidly dimensioned and exactly determined wave length, the variable tuning condenser of, for instance, the spark-gap apparatus Brevi

(1) Spark gap apparatus are constructed in Germany principally by the following firms: Siemens Reiniger Werke A.G., Berlin; Koch & Sterzel A.G., Dresden; Elektrizität gesellschaft Sanitas, Berlin.

flux (S.R.W.) is arranged in such a manner that the capacities of the primary and the secondary are varied simultaneously and in this way obtain the tuning effect.

But the altering of the capacity of the primary results in a corresponding modification of the wave length produced, the value of which depends on the object to be treated and the special treatment conditions prevailing in the case (capacity and self

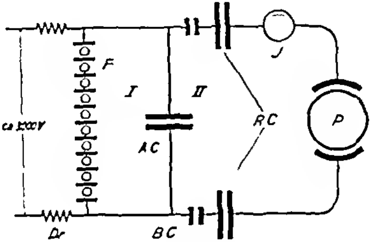


Fig. 23

Diagram of the spark-gap apparatus Breviflux.

Dr = choke coil

F = spark-gap assembly consisting of ten parts, each spark gap being adjusted individually

I = primary (hospital) circuit, II = secondary

AC = tuning condenser

RC = regulating condensers adjusted simultaneously by one knob

BC = fixed condensers for keeping the high voltage out of the secondary

J = indicating instrument for tuning the primary to the secondary

P = patient between the pliable electrodes

induction of the secondary). With the Breviflux and other apparatus of similar shape the wave length is varied within the range of from 6 to 12 metres, as may be seen on the table given on the following page.

Moreover, the specific electrical conditions require a number of spark gaps which is about 10 times higher than that used in long wave diathermy for obtaining satisfactory electrical outputs.

**Table of the wave length of a spark-gap apparatus (Breviflax).**

| Object to be treated | electrode cm | distance mm | wave length metres about |
|---|---|---|---|
| elbow joint | 6 × 8 | 10 | 6 |
| jaw | 6 × 8 | 5 | 7.5 |
| knee | 8 × 14 | 5 | 9 |
| | 12 × 18 | 5 | 10 |
| thorax | 12 × 18 | 5 | 10 |
| | 18 × 27 | 5 | 12 |
| across hip | 12 × 18 | 5 | 12 |
| | 18 × 27 | 5 | 12 |

This increased number of spark gaps is necessary because the efficiency of the spark-gap is small in the short wave range. While with long wave diathermy apparatus outputs of from 150 to 200 Watt can be obtained with one spark-gap, in the short wave apparatus on the contrary with one spark gap therapeutical net outputs (1) of from 10 to 12 Watts only (2) can be produced within the wave length range of about 10 to 15 metres. When the wave lengths are reduced to smaller values the outputs obtainable are still smaller. (See Fig 28 on page 48.)

The difficulties of a fundamental character which thus arise compel us in practice to adopt a compromise so that one must be content to obtain considerably decreased outputs as compared with those obtainable in diathermy and from valve equipped therapy apparatus. Apart from this one foregoes generally the use of wave length shortened to an extent usual in valve equipped apparatus. However practical experience has shown that within certain limits this is a practicable way of achieving reliable treatment results.

According to the articles published by Schliephake (3) the effects obtained with short wave apparatus equipped with spark-gaps are better than those achieved in diathermy but by no means comparable with the results which can be obtained with the aid of valve equipped apparatus of higher outputs. The spark gap equipped

(1) *The term "net therapeutical output" or "therapy output"* (which means the same) is used in contradistinction to the "maximum output" (see page 53.)

(2) According to measurements carried out by Fritsch with the aid of a lamp phantom (see page 55), whereby a tolerance of ± 10% should be allowed.

(3) Schliephake Short wave therapy 1935, page 36.

short wave apparatus Breviflux (S.R.W.) is fitted with 10 spark gaps as opposed to the preceding types Variotherm and Brevitherm which were provided with more and less spark gaps respectively.

The output numbers relate to an ohmic resistance corresponding to the value of that of the thorax.

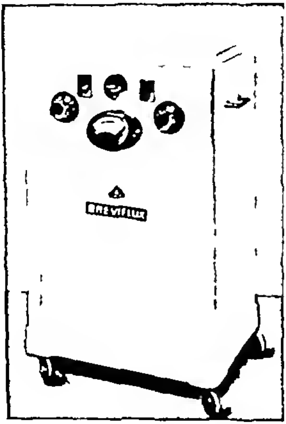


Fig. 24

Spark gap equipped short wave apparatus Breviflux. Wave range from about 6 to 12 metres. Net therapeutic output about 110 Watts at a wave length of 12 metres. Left hand rotating knob = tuning condenser; right hand rotating knob = regulating condenser.

Figure 25 illustrates the constructional design of these spark gaps. They are arranged **horizontally in one line** facilitating with such a construction the cooling necessary for the apparatus when used during long periods and with high load. A slot shaped window in the upper cover plate of the metal casing allows the sparking of each gap to be observed immediately so *that it is*

possible to recognise at once an imperfect operation of any individual spark gap

We invite special attention to the fact that each individual spark gap can be regulated by means of a knob, that is without tools, during the service, to the optimum distance of the gap which is a few hundredths of a millimetre only

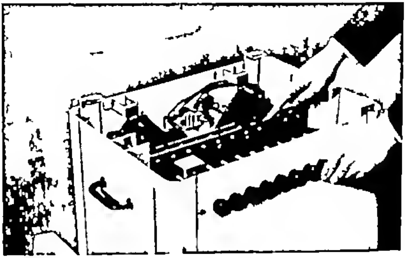

Fig 25

The spark gap and the variable condenser of the B r o v i f l u x. Each individual spark gap can be adjusted during the service by means of a rotating knob The most favourable cooling conditions have been obtained by arranging the spark gap horizontally in one range

Experience has shown that spark-gaps of short wave apparatus are more exposed to failures than those used in diathermy apparatus as they have to be adjusted to considerably smaller distances. Therefore operators of spark gap equipped short wave apparatus must be able to eliminate accidental troubles by themselves without loss of time and without switching off the apparatus, and this is designed for this purpose

Individual adjustment of each spark gap will prevent the operation from being continued during incorrect working of the spark gap for in this case the spark gaps which are in good working order would be charged to a higher degree and in such a way possibly cause other disturbances or even defects

Finally [illegible] for to the peculiarity that the B r o v i f l u x apparatu is equipped [illegible] current meter (current indicator) It is true that in some [illegible] equipped apparatu such an instrument [illegible] not

filled however it may be more or less advisable or even necessary to be able to supervise by means of a pointer instrument the constancy of the adjusted dosage or apparatus output during the treatment for the purpose of readjusting the output to the correct value if required.

**Elimination of broadcast interferences.** The question of broadcast interference elimination is of higher importance with spark gap apparatus than with the valve equipped type which generally do not produce interfering waves. As a rule spark gap apparatus which has not been equipped with suitable interference eliminator will generate heavy disturbance oscillations. These oscillations are spread partly over the main leads to the apparatus, partly as space waves. The former action of interfering oscillations causes more serious disturbances. They are eliminated by means of condensers and choke-coils specially constructed for this purpose which are connected to the main leads of the apparatus. Sometimes certain interference eliminators of restricted effect are connected to the apparatus in the workshop, in this manner providing for a partial elimination which often fulfils the requirements. This is also the case with the Reviflux. The space waves are really screened off by the metal cabinet of the apparatus but only practical experiments made at the place of erection will show whether the partial interference elimination provided for in the workshop is sufficient or whether other additional measures are necessary as local conditions can seriously (and in an unexpected manner) influence the interference.

The latest and most effective measure to be taken against interfering space waves is the faradic cage which consists of an earthed wire mesh applied to the operation room or of a wire mesh cage surrounding the apparatus and the patient. This method of interference elimination is however very seldom employed in practice.

Nevertheless the primary costs of a valve equipped apparatus which per se does not produce any interference may be less in many cases than those of a spark-gap apparatus which need additional measures for eliminating broadcast interferences. In addition, care has to be taken that the broadcast receiver is in good condition from a technical point of view. This has already been explained in detail.

## IV Physical differences between short wave energies produced by valve equipped and spark gap apparatus.

Many authors do not consider the valve equipped and the spark gap apparatus to be of equal value from a therapeutical point of view. Other authors contest this opinion. The physical differences between the short wave energies produced in these two types of apparatus are often doubted or even controverted. Therefore we shall go into the details of the relevant considerations (oscillation damping, uniformity of the wave lengths, wave mixture) in order to clear up the matter on behalf of the practitioner interested in physical problems.

**Differences of the oscillation curves.** As already referred to on page 15 an oscillating circuit excited by an electronic valve generates undamped oscillations of a strictly determined wave length (see Fig. 9 page 20, Figs. 15 and 16 pages 28). Contrary to this the spark gap produced waves are damped (Fig. 10, page 21), forming a wave mixture around a predominant wave length. However these exact conditions exist in the primary circuit only, coupled directly *to the valve or to the spark gap respectively, and are* not *applicable* without certain restrictions for the secondaries, inductively connected to the primary, as in these some alteration in the oscillation takes place to a varying extent and these will be described later.

On the other hand, as regards their characteristic wave form and wave length, the oscillations produced in the secondary of a valve equipped apparatus and applied to the patient are strictly of one invariable length only, which is determined by the electrical dimension of the primary.

This is due to the fact that the primary of the valve equipped apparatus produce oscillations of one wave length only, which consequently is induced in the secondary in this determined form, for external conditions, as for instance the electrode skin distance, influence the secondary only and do not operate upon the primary or the oscillations generated by it. This can be ascertained in practice.

The short wave energy produced by a valve equipped apparatus may therefore be compared with a medicament of uniform chemical composition and concentration the therapeutical effect of which is characterised by one physical constant only that is to say, the dosage ratio

Different working conditions prevail in the spark-gap equipped short wave apparatus which are characteristically influenced by the

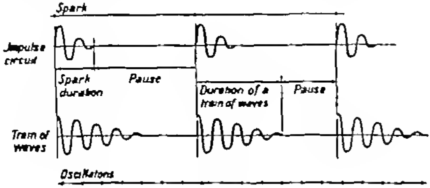


Fig 20

Curve of the damped oscillations in the primary and secondary circuits of the spark gap equipped short wave apparatus

Only a few oscillations can be produced in the primary with each individual discharge as every oscillation spark is extinguished shortly after it has been generated owing to the de ionisation effect of the spark gap. The groups of the sparks or oscillations respectively follow each other within certain intervals necessary for completing the new charge of the primary condensers which have been discharged by the preceding spark The oscillation flow is of longer duration in the secondary so that the intervals are shorter than those of the primary The apparatus is designed to give a great number of sparks (rising to some 100 000 per second with short wave apparatus) to reduce the oscillation periods as much as possible The length of the interval varies in practice and increases with the output produced because the damping effect rises in this case

rapid decrement — or more accurately immediate rupture — of the oscillation in the primary due to the spark resistance and the quenching effect These phenomena are similar to those produced in the earlier days in broadcasting technique with the spark-gap transmitters in use at that period In the secondary circuit an increased decrement is obtained as may be seen from Fig 20

Assuming theoretically that the secondary circuit is without limit resistance and without energy it would oscillate permanently

with undamped oscillations when excited by the primary. But the natural energy losses due to the resistance (Joulean heat effect), and the radiation, cause a decrease and decrement of the amplitudes produced, that is to say, a damping effect is applied to the oscillations which is **proportional to the energy withdrawn from the circuit or transformed into heat within the windings**.

This process is completely analogous to that observed in the acoustical oscillations of a piano wire which are damped by means of a convenient device absorbing the oscillation energy so that the tone produced decreases rapidly. When this device (pedal) is not employed, slowly damped oscillations of a certain period are obtained.

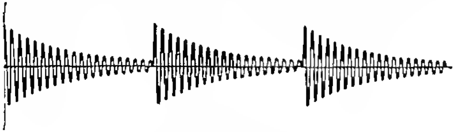

Fig. 27.

Slowly damped oscillations in the secondary circuit of a spark gap equipped short wave apparatus.

The oscillation curve of a slightly damped character as shown in the figure is only obtained when no energy or at least a reduced output is taken from the secondary, that is, the output current of the apparatus. **Increased energy output will result in a greater damping effect and consequently in the production of intervals.**

If a **loss free medium** — air for instance — is inserted instead of the patient's body between the electrodes of a spark gap equipped short wave apparatus, a reduced damping of the secondary will result. Therefore owing to the fact that the energy withdrawn is practically zero, and it may be **supposed** that in such an **unloaded** (or lightly loaded) secondary — when certain conditions (careful spark gap adjustment and very loose couplings between the primary and secondary) are fulfilled — a new set of oscillations will begin as soon as the preceding group has ended.

Earlier writers do not appear to have referred to this fact in the literature ... using **short wave apparatus**. With **long wave diathermy** apparatus for surgical purposes on the other hand Bode

mann (among other writers) has verified this slight damping effect by means of an oscillograph ( ) and this is noted by Leistner and Schaefer in an article dealing with short wave apparatu

When energy is taken from the patient s circuit of a spark gap equipped short wave apparatu by tran forming it into heat inside the patient body a damping effect will result therefrom which increases with the rate of withdrawal of energy causing the oscillation to decrea e with a correspon ding speed so that shorter or longer intervals arise between the individual oscillation groups (Figs 26 page 43)

When fully loaded, which i generally necessary when u ing spark gap apparatu in therapy owing to it low efficiency this damping effect naturally reaches very high values obeying certain definite laws Thi can be verified with oscillographic curve taken with a cathode ray oscillograph.

Leistner and Schaefer ( ) have publi hed the o cillogram of a 15 metre wave produced by a spark gap apparatus which clearly shows the relatively long intervals between the individual damped oscillation group

**Fixed and Variable Wave Lengths** As already referred to on page 8—10 the wave length produced by a spark gap apparatus i not exactly fixed but contrasted with those generated in a valve equipped apparatu it is dependent on the product capacity C × self Induction L exi ting in the patient circuit according to Thom on formula.

Consequently different wave length are obtained in accordance with the treatment condition which determine the product C × L and are of different character in each individual ca e a may be seen from the Table on page 16

The output obtainable in therapy with varying wave length are very different a hown in Fig 28

(1) Dr Ing Bodemann. Dresden. Über die gun tig te Stromform von El ktrochirurgi apparat n (Note on the most favourabl current wa e form of lectro-surgical apparatu ). Chirurg 1934. Vol. 8 page 327

( ) Dr K. Leistner and Dr H. Schaefer Dresd n. Untersuchungen an Kurzwellen Funken treckenapparaten (Investigation on park-gap equipped short wa e apparatu ). Strahlenth r 52, H 4. page 681 (1935)

Therefore the effect produced by a spark gap equipped apparatus cannot be compared with the constant efficacy of a chemical medicament of unvarying quality. Granted that it is possible to fix approximately the wave length aimed at by selecting definite electrode distances or by employing intermediate layers of a certain thickness rigidly attached to the electrodes if desired, and by using different cable lengths (checking these measures by means of a wave meter) certain difficulties will arise in spite of this, such as for instance, in

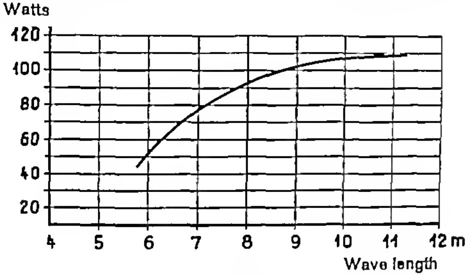


Fig 28

The output of a spark gap equipped apparatus as a function of the wave length

The output values of the spark gap equipped apparatus refer to the upper part of the available wave length range. When the electrode skin distance increases the output decreases as may be seen from the curve

convenience greatly reduced energy density of the short waves with electrode of large size so that almost in every case in practice modifications of the wave length occur

**Predominant wave, mixture of wave lengths, uniform wave length** It must be understood that the "wave length" of a spark gap equipped apparatus in normal therapeutic practice is really a wave mixture of several *lengths superimposed* upon a predominant wave which is called the "wave length" According to the extent to which the energy in the patient's circuit rises the wave mix

ture is increased and decreases more or less when reduced outputs are taken from the secondary. This latter proceeding is, however, in opposition to the requirements generally needed in therapeutic practice.

From a physical point of view the fact which is applicable in the same manner to both the spark gap equipped apparatus of old and recent design, setting aside some small differences, is due to the high selectivity of the unloaded oscillatory circuit (secondary) and to the heavy decrease of selectivity in consequence of the increased load.

The totally unloaded (or very lightly loaded) secondary circuit of high selectivity to a very high extent filters out of the wave mixture prevailing in the primary the predominant wave which is tuned by means of the tuning condenser to the natural wave length of the individual patient's circuit.

On the contrary, when the secondary is normally loaded, as is necessary in therapeutic practice, and for this reason has lost its selectivity, it operates like a broadcast apparatus receiving, owing to its defective selectivity, besides the predominant station a number of other stations simultaneously, so that a discordant chaos is heard.

We may also use the term "single wave" for such spark-gap equipped apparatus the wave mixture of which contains only one predominant wave in contradistinction to another spark gap apparatus designed to be adjusted to a second or even to a third predominant wave. But the denomination "single wave" is mostly understood incorrectly as if such an apparatus produced a pure wave exclusively without a superimposed mixture of other waves. To avoid this error it would be preferable not to use the significations "single wave" or "definite wave length" in conjunction with spark gap equipped apparatus.

**Resonance curve and damping curve.** An approximately pure wave is obtained in the spark gap equipped apparatus with the secondary circuit unloaded or only lightly loaded. Resonance curves obtained by means of a wave meter (Fig. 29 and 30) show the degree to which such a wave has other waves superimposed on it, and diagrams of these relations are represented in Fig. 31 for comparing the conditions prevailing in a spark gap equipped apparatus with those of an apparatus with an electronic valve.

Fig 29

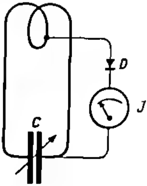


Fig 30

Fig 29 Wave-meter

The wave meter consists of an oscillatory circuit with variable condenser and resonance indicator For carrying out the wave length measurement, the instrument is put near the dielectric (within the field of the electric lines of force) of a cable or an electrode. Then the knob of the condenser is slowly turned round the scale until the resonance indicator (small luminous tube or incandescent lamp or some type of measuring instrument) shows the peak of oscillations. In this position resonance is obtained, the scale value read off from the variable condenser indicating the wave length. For recording the resonance curve the wave length meter must be equipped with a measuring instrument (current indicator)

Fig 30 Connection diagram of a wave length indicator with measuring instrument (current indicator) and rectifier

The rectifier D connected the circuit rectifies the high frequency oscillations, which are indicated by the sensitive DC moving-coil instrument J By means of the variable condenser C the capacity is regulated to such a value that the pointer deflection upon the scale is a maximum. In this pointer position the wave length value can be read off directly from the condenser scale or calculated with the help of a calibration curve

When a wave of pure uniform length is produced by the oscillatory circuit to be tested, the measuring instrument indicates the current only in one definite position of the variable condenser whereas a wave [illegible] causes the pointer to deflect within a wider range of the scale

Practically speaking the curve R of the valve equipped apparatus begins and ends upon the axis of abscissae (theoretically there is an asymptotical approximation). This peculiar quality characterises and proves the uniformity of the wave length produced. The curve F of the spark gap equipped apparatus on the contrary is slightly removed from the axis of abscissae as regards its beginning and end points and besides appears widened at the lower parts thus proving that this circuit oscillates **only approximately or within practical limits at one wave length**, so that there is a certain mixture of different wave length the range of which is represented by the abscissae of the curve F.

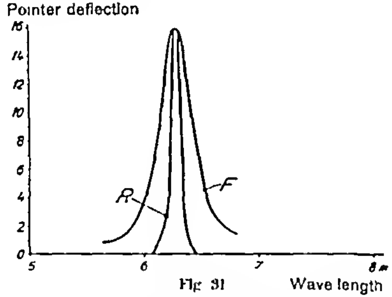


Fig. 31

Resonance curves of the wave meter connected with an **unloaded valve equipped apparatus** R and an **unloaded apparatus with spark gaps** F.

The curves are recorded in such a way that the knob of the variable condenser coupled to the secondary of the short wave apparatus to be tested is moved slowly round the scale of the wave length, registering thereby the pointer deflection obtained with the individual wave length. In the case illustrated in the figure the conditions have been chosen so as to obtain constant maximum values of the pointer deflection for constant wave length value with both types of apparatus for facilitating the comparison of the two types. If the resonance curve had been recorded with the apparatus connected to a higher load the maximum value of the curve R would surpass that of the F curve according to the higher output of the valve equipped apparatus. The difference in the curve form proves that there is a slight wave mixture in the waves produced with the spark gap equipped apparatus.

So therefore, the resonance curve of a spark-gap equipped apparatus, recorded with the secondary normally loaded, that is under the conditions prevailing in actual therapy will be verified to be considerably deformed owing to the modification of the oscillations originated by the load of the secondary, which results in an increased damping effect, decreased selectivity and enlarged range of the wave mixture On the other hand, the curve of the valve equipped apparatus remains of the same characteristic form.

Figure 32 demonstrates two resonance curves recorded with the apparatus under load Just as in the case illustrated in Fig 31, the curve R of the valve equipped apparatus reaches the axis of abscissae at both its ends thus proving the uniformity of the wave length generated by the apparatus under load. The curve F of the spark gap equipped apparatus, on the contrary shows an increased distance from the axis of abscissae at both ends

These distances are of importance as they attest the presence of a superimposed wave mixture, the distances n (ordinates) being a measure of the value of the superimposed waves.

It is true that there is also a literature asserting that a wave length mixture is not produced in spark-gap apparatus of modern design. These statements, in disaccordance with the stipulations explained above could ee ily be verified if the oscillations in question refer to lightly loaded spark gap apparatus In every case no mention has been made of the fact that the conditions of the oscillation generation are modified with the altered load.

**Relations existing between the physical and the therapeutical effects.** It has not been decided whether as seems improbable the differences existing in the spark gap or valve produced oscillations also result in different biological and therapeutical effects sup posing that the same wave length and equal outputs are applied in both cases

Under definite working conditions relating especially to the wave lengths and outputs to some extent equal or similar physical effects are obtained by experiments In particular selective heatings of solution of electrolytes can be achieved al o with damped waves ( park gap oscillation ) although there i n uperimposed wave mixture In thi case the elective heating is obtained with the predominant wave only whil the superimposed waves which do not fulfil the con ditions im d by the selectivity continue to be non-effective

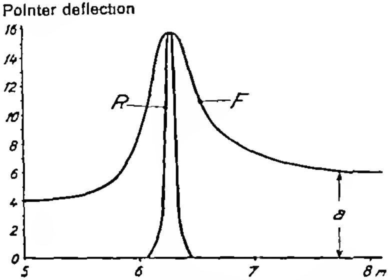


Fig 32

Resonance curves taken by the wave-meter with the apparatu normally loaded

Curve R (Valve equipped apparatus) shows the same peaked form as illustrated in fig 31 owing to the fact that the uniformity of the wave length ist not modified by the load (monochromatic oscillation) The much widened curve F (spark gap apparatus) and the increased ordinate value a, prove the existence of a large wave mixture due to the load of the apparatus (polychromatic oscillation) with the predominant wave length of 6.3 m.

Resonance curves can be recorded also without the wave meter if the capacity values of the tuning condenser placed in the secondary circuit are altered and the values of the current corresponding to the capacity values are recorded as ordinates These currents are registered by the current indicator connected to the apparatus Curves drawn in such a way show a flattening and enlargement of their form, even when taken with a valve equipped apparatus which, however cannot be due to a wave mixture as this cannot be generated here in any way

Therefore in order to test the uniformity a waved or multi waved form of the oscillations produced by short wave apparatus only such resonance curves should be used which have been recorded by means of the wave meter (wave meter resonance curves)

When, besides only small quantities of liquid are heated, for instance in a test tube (Raab), the superimposed wave will produce reduced effect in these circumstances owing to the decreased load of the apparatus and it will not be surprising if similar experimental results are achieved by such a method.

But as in both cases in practice the conditions of equal output and uniform wave lengths both in valve and spark-gap equipped apparatus (conditions which must be presupposed to be necessary for obtaining identity or similarity of the effects realised in the experiment), are not normally fulfilled, investigations of this kind do not justify the conclusion that similar physical reactions can be obtained inside the patient's body

Raab (¹) (l c. page 50) is of opinion, that there are no biological and therapeutical differences between the effects originated by damped and undamped short waves or between valve equipped and spark-gap equipped apparatus respectively

If, in spite of this, very well known authors, such as Schliephake, Kowarschik, Liebosay and others refer to inequalities in the therapeutical effect realised with both the apparatus types, and, as in addition the greater part of authors of this special literature all over the world employ valve equipped apparatus, one is justified in supposing that these facts are at least due to differences in the physical effects generated within the patient's body which on their part are produced by the disparity of the outputs prevailing in the majority of cases, such as inequality of wave length and the difference in the electrode distances obtainable

Schliephake characterises these differences by signifying by the term "short wave therapy" the treatment method carried out with valve equipped apparatus and with "short wave diathermy" that of the spark gap apparatus Liebesay (l c page 3) and other authers follow this classification

Kowarschik (¹) exposes clearly the differences of operation of both the apparatus types by saying "It is easily to be understood that an apparatus producing undamped and therefore continuous oscillations is better fitted to give high output than another generating damped and interrupted oscillation, in view of the fact that a workman working without interruption will do more work than another who always rests a little after having carried out some operation This comparison will be applicable even to valve equipped apparatus working in half wave service for the ratio working time — rest time is far less than the ratio — 1 1 in spark gap equipped apparatus

1 Kowarschik Ärztliche Praxis 1934 Vol 13.

## V Critical considerations concerning short wave apparatus with regard to output and therapeutical efficiency

There is a direct relation between the electrical output of a short wave apparatus measured in watts and its therapeutical efficiency. Therefore strictly determined output data should be asked for when ordering short wave apparatus like those indicated when applying X-Ray apparatus where this method has been the usual practice for many years. Merely stating the number of watts means little or nothing. It is necessary to know the condition and especially the wave length — for which the indicated output is obtainable. In the following we shall deal with the most important factors determining the output and demonstrate at the same time how the physician can estimate the output and the therapeutical efficiency of an apparatus by himself by his subjective heat sensation even without the help of measuring instruments.

**Maximum output and net therapeutical output.** The therapeutical effectiveness and efficiency of the short wave apparatus are dependent on the wave length and the electrical output available in the field of force of the electrodes under normal therapeutical conditions.

Hitherto however the frequency technique has not provided instruments suitable for measuring this net therapeutical output directly and during the treatment so that to-day the only practicable method of measuring the therapeutical effective output (in watts) of a short wave apparatus is by means of an artificial phantom of such a shape that it absorbs within the condenser field the same energy rate as does the human body.

Therefore these peculiarities should always be taken into consideration when considering output indications in watts of an apparatus as sometimes these indications have been made

taking into consideration general electrical points only and not the therapeutical ones, so that only the maximum electrical output obtainable with the apparatus is indicated

All output indications in watts are worthless and misguiding in the practice of therapy if they do not refer precisely to that output which under normal working conditions is available for therapy proper, that is to say, the output useful in therapy or briefly stated, the net therapeutical output, but indicate another output established by means of some measuring device or phantom, which does not correspond to the conditions prevailing in treatment practice and instead of this, absorbs from the apparatus an energy rate as high as may be desired (maximum output)

In order to clarify these conditions we shall briefly enter into the principles upon which the different testing methods are based

**Calorimetric output test.** When a tissue paste placed in a glass trough is put between the treatment electrodes, the energy in watt transformed to heat be calculated by the temperature rise produced in a definite time provided that certain conditions as regards the measuring technique be fulfilled (Calorimeter method) Output measurements of this kind carried out on muscular substances or fat with the apparatus fully loaded will show a highly increased output rate with fat as compared with muscular substances It is evident that by mixing convenient different tissue particles to form a homogeneous mass it will be possible to obtain an phantom of such a nature that it is equal as regards its energy consumption to the corresponding average value of the human body, and that further more a comparison phantom can be produced in a still simpler manner with a salt solution of strictly determined concentration

Measurements made with such a phantom are irreproachable from a practical point of view and can be marked Therapeuti cally u eful output" or "net therapeutical output measurement

In contradi tinction to this any measurement made with a salt olution of a different concentration would be unreliable but they would be cho en with a view to rai ing its absorption capacity or with reference to pecific selectivity of the wave length and the

originating the selective heating effect (maximum output) The results of measurements taken by this phantom would be theoretical merely and would surpass the average outputs available in therapy by 100 %

It is likewise misleading to determine the apparatus output calorimetrically by means of receptacles of too small volume (test tubes), owing to the fact, that the electrical resistance conditions prevailing are totally different as compared with those existing in the human body The length of the path the current passes through as well as the volume of the liquid heated should always correspond as closely as possible to the real conditions in therapy

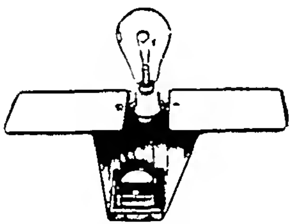

Fig 33.
Lamp phantom with Photometer for photometrical output measurements on short wave apparatus up to about 350 watts.
The electrodes are placed up on the metal plates with the usual spacing (intermediate felt layers)

**Photometric output test.** Photometric methods can be used for testing output in Therapy instead of the rather lengthy method of calorimetrics here the electrolyte is replaced by an ohmic resistance (calibrated carbon filament lamp) connected in parallel to capacitative resistance of definite value so that the brightness of the incandescent lamp can be measured the number of light units (lux) is calculated by a calibration curve and gives the Therapy output in watts The simpler transportable device for output measurement up to 350 watts with a fixed capacity (lamp socket) instead of the adjustable capacity of the condenser is shown in

| Type of apparatus | Approximate wave length | Therapeutic output in watts (approx) | Approximate price of apparatus £ | Approximate price per watt sh | Relative price |
|---|---|---|---|---|---|
| Valve Machine Ultratherm, Model 1935 | 6 m | 300 | 100 | 4/— | .38 |
| Spark-gap Breviflux Model 1935 | 6 to 12 m | 110 | 62 | 5 — | 1 |

Service cost with valve apparatus for

Treatment time of 15 minutes and a service duration of 1000 hours about 2 d.
Service duration of 2000 hours 1 d.
Service duration of 3000 hours ½ d

**Choice of apparatus.** The question of spark gap or valve machine must be dependent on the type of work aimed at we must, however point out that to judge by the literature by far the larger number of writers (Physicians) are in favour of the valve apparatus. In Germany when Short Wave Therapy was first introduced, the Spark gap machine found many adherents this was probably due to special reasons, such as the great restriction on patent rights for valve apparatus, and the relatively low first cost of the Spark gap machine German medical literature however, of 1935 shows that now three authors out of four prefer the valve machine (See Manuals referred *to on page 2*)

## Electrodes

Three main types must be considered

(1) Rigid electrodes

(2) Pliable

(3) Special electrodes for body cavities etc

The metal electrodes incorporated in the glass covers or shoes can easily be adjusted to suitable skin distance in each ca e (fig 35)

Schliephake glass electrodes belong to the first type for design and construction see fig 35

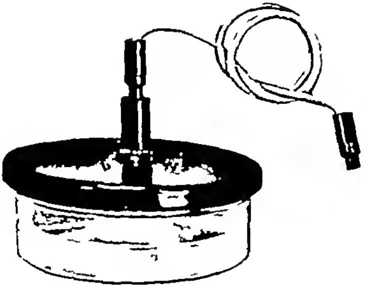

Fig 35
Schliephake glass electrode

**Pliable electrodes** (fig 38) These are sheets of metal foil enclosed in rubber sheaths, which have been specially treated and pressed and which never become too hot with use with the u ual energy density common in practice The pressing process enables one to di pen e with any vulcanised joints or pla ter arrange ment which lead to puncture

The depth effect obtainable with pliable electrodes i sufficient in many case e pecially in the out patient s department of a

Hospital, where comparatively superficial treatments are the rule If however, strong depth effect be desirable, Schliephake s electrodes can be used.

Pliable electrodes should be kept in position by sandbags or bandages, or, the patient may lie on them The most important of

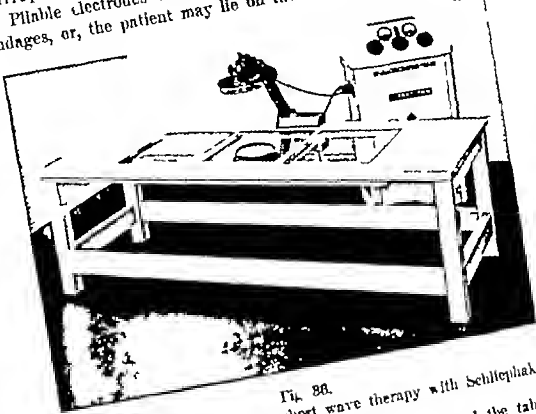

Fig. 38.
Operation table or couch for short wave therapy with Schliephake electrodes.

A penetration window is provided for in the floor of the table consisting of "Condensa" an almost loss free material which can be passed through easily and does not produce unfavourable heat effects. The window can be inserted on different parts of the table which is composed of several exchangeable wooden panels.

the special electrodes are shown in Figs 39 and 40 With both of these indifferent pliable electrodes can be used (See Figure 34) Unipolar treatment is also possible, but not often recommended as it greatly reduces output of apparatus, or else the machine has to be adjusted to a much higher output in order to get any penetration

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(1) Kowarschik, Investigations in Short Wave Therapy K.L.W.S. 1933. Vol. [illegible] [illegible]mann & Fritsch. Med. Clin

(2) The question of Electrodes in Short Wave Therapy 1933. Vol. 11

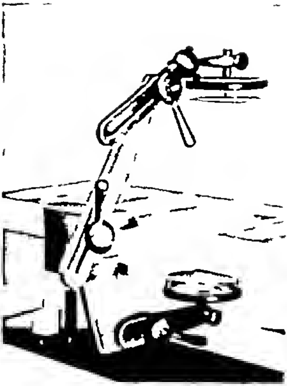


Fig. [illegible]

An[illegible] adjustable device for fixing the [illegible] plate [illegible] to [illegible] table

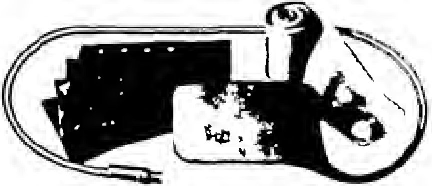


Fig 39

Fig 40

Fig 41

Fig 39 Schliephake's Furuncle electrode specially designed to avoid contact with furuncle distance adjustable

Fig 40 Schliephake's Axilla electrode for treatment of hidro adenitis (axillary abscess)

Fig 41 Vaginal electrode

# VII Principles of technique in treatment

**Different Methods.** Schliephake gives the following three methods of treatment:

1. Ultra Short Wave Therapy proper with valve apparatus and wave length up to 10 metres, energy output [illegible]00 to [illegible]00 watts approximately, electrode skin distance or spacing of 2 to 8 cm.

2. Short Wave Artificial Fever therapy (electropyrexia) with valve machines of special design producing waves of 12 to 20 metres, to be preferably applied when general body heat effects are aimed at rather than local treatment; energy output [illegible]00 to 1000 watts approximately, with electrodes of large size placed lower and at some distance from the body surface and at approximately [illegible] to 10 cm each.

3. Short Wave Diathermy with spark gap apparatus producing waves of 10 to 30 metres, generally 10 to 20 metres, output approximately 80 to 200 watts, electrode skin distance a few mm. Valve apparatus producing waves of [illegible] metres practically belong to this class.

## 1 Special principles of technique in ultra short wave therapy

**Importance of Spacing or "Distance" Treatment.** Ultra [illegible]

of temperature permissible for the surface layers (subcutaneous fat etc ) This condition is best fulfilled by spacing or distance treatment in the free condenser field

Characteristic of this kind of treatment is the wide spacing of the skin electrode distance which alone creates the physical conditions which ensure a really strong energy density in the depths of the tissues with the smallest possible surface heating

A great deal of experimental work has been done on this subject by Schliephake, Kowarschik, Liebesny Gobbert, Pätzold, Beetz etc., and three of them have collected much therapeutic

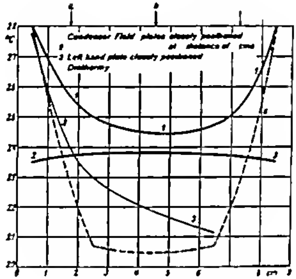


Fig 42.

Shows dependence of depth heating on spacing taken from Schliephake s book, l e page 3

As experimental material bread was used with insulating layers introduced at a, b & c This shows the condenser field

experience showing the practical importance of spacing in the condenser field It is easy to demonstrate how greatly depth effect depend on electrode distance or spacing This is shown in Gobbert s experiment (Figure 43) The dotted line represent a pig bladder filled with minced meat To right and left are Schliephake s electrodes (8 to 10 cm in diameter with glass cover wavelength is 6 metre ) The Figure shows the temperature curve in the central part of bladder at a right angle to the line of force

Another experiment on the same lines had practically the same result (1)

This experiment is interesting in so far as it shows that an electrode that is placed very near the body (curve 2 fig 43) with a spacing of only a few mm as compared with 6 mms in above case has a very poor depth effect even less than that obtained by bare metal electrodes (curve 1 fig 43) Strong depth effect can only be obtained by adequate spacing

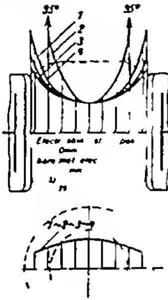


Fig 43

Depth effect in relation to electrode distance (Gebbert)

The dotted line represents a phantom body (a pig bladder filled with fresh minced meat) On the right and left hand side Schliephake electrodes of 8 cms diameter with glass shoes have been applied Wave length 6 metres

Below will be *found temperature curve for centre section of the* phantom at right angles to the direction of the field.

The same has also been ascertained by Kowarschik (2) who examined the leg of a cadaver and showed that pliable condenser electrodes placed near result in depth effect of even smaller value than is the case of long wave diathermy

(1) Gebbert on the dependence of the superficial depth effect in ultra short wave currents on the kind and spacing of electrodes Journ Clin. W. S. 1934, page 935

(2) Kowarschik, Versuche mit Kurzwellen Therapie (Experiments made with short wave therapy) Klin W chr 1933 Page 175

Fritsch recommends in place of thermometers for measuring depth effect a vessel filled with pur water without electrical connections (Fig 44). The field explorer or sound is a small plate condenser which absorbs from the lines of force an energy rate proportional to the field density prevailing at that point, which is transformed into an electric current and conducted to a small incandescent lamp (cystoscope lamp). An electric measuring device can also be used. The brightness oft the small lamp or the indication of the measuring device is a measure of the absolute electrical depth effect. Using a field explorer saves time as it is not necessary to wait for a temperature rise

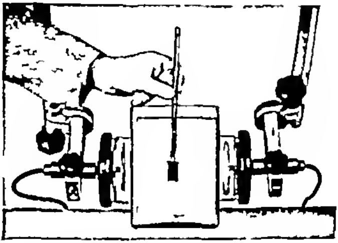


Fig 44.
Field Sound with small bulb inside water-phantom. — The field-sound ascertains distribution of field inside the water phantom in relation to the size and spacing of the electrodes

The thicker the body part to be treated, the greater the electrode skin distance to be applied and the heavier are the energy restricting effects (capacitative resistances) of the dielectric intermediate layers (air) Only with ultra short waves is it possible to overcome these difficulties

If waves that are too long (too weak) be used, sufficient energy cannot be transmitted, hence the idea crops up now and again in the literature that energy is dissipated by distance treatment This however never occurs if sufficiently short waves are used With 6 metre waves, the capacitative resistance and choke effect on energy are very small as can easily be proved by the experiment of the lamp in the water bath (Fig 44)

Using Schliephake's electrodes of 180 mm. diameter the *Ultratherm* showed an output of 320 watts with electrode-skin distance of 1 to 2 cm. but, with distances of 5 cms., 300 watts was still obtained (which means a loss of energy of 20 watts).

It is true that a fair sensation of heat with a certain amount of depth effect and therapeutic results can be achieved by using reduced electrode-skin distances, as in *Short Wave Diathermy* but this method is not the true and classical Ultra Short Wave Therapy with large energy density and short wave lengths.

**Depth law.** In order to get the full optimum depth effect the treatment of thick parts of the trunk, such as thorax and abdomen, the depth law must be strictly observed; *this states that with an apparatus of good energy output and fixed wave length, the best depth effect is obtained by making the skin electrode distance as large as possible with maximum energy, until the patient experiences a warm and pleasant glow.* In applying the depth law and in selecting suitable skin-electrode distances in accordance with it, the following factors are of importance:

1. Thickness of part.
2. Output and wave length of apparatus.
3. Size of electrodes.
4. Distance of electrode from the skin, and character of the intermediate layers present: clothing, felt, etc.

Both theory and experiments have shown that electrodes of larger size enable one to use wider spacing. The influence of the intermediate layer is always unfavourable if it has a heat "insulating effect" or if it produces "*surface heat*" which again depends on the kind of thickness and on any degree of moisture present in any articles of clothing. Under these conditions the skin can only tolerate a greatly reduced field energy, which means a diminution of depth effect even if the skin-electrode distance is increased. It is much better to dispense with clothing.

*When depth effect* in trunk or hip joint is required, the rule should be to have only one layer of thin underwear or better an absorbent material over the part to be treated, this can be renewed if sweating takes place. The selection of the most advantageous spacing or electrode skin distance is made easier by tables giving the suitable electrode sizes for certain skin distances which are furnished with each apparatus.

**Treatmeot of the skull** These treatments which involve deep penetration of bony masses includiog diseases of the teeth, antra, sinuses, ethmoidal cells, organs of hearing, should be carried out with Schliephake s electrodes io a suitable holder Pliable electrodes can, however be used when heatiog of the outer soft parts 1 intended, but this is not advisable on the face It is neither hygienic nor agreeable and bandaging of the face may cause sweat formation and lead to undesirable heat effects, which again leads to reduction of the dose, and spoils the effect Thus by neglect of a strict technique the real effects of Short Wave Therapy can be completely destroyed and a superficial warming effect *produced as by ao electric pad*

In treatments of the braio, the dose should be very mild until the patient s reaction is known ond if next day no nervous symptoms are complained of, it can be increased

**Vertical treatment through the limbs.** Here the electrode skin distance to be applied depends oo the depth effect desired thicker part such as the thigh, demand the maximum electrode distance and the maximum energy output of which the apparatus is capable The largest Schliephake electrodes will give the best depth effect here

In using pliable electrodes too large sizes should not be used os owing *to the* reduced *distance necessary* in *some of these* cases the electrical energy is apt to conceotrate at the edges of the electrodes this reduces depth effect A later chapter will explain the course of the lines of force and the technical difficulties of these treatments

**Longitodinal Treatment of Extremities.** This is used mainly when the chief effect is to take place in the soft parts this mode of treatment can be done over a certain amount of clothing a , if sufficiently large pliable electrodes are u ed with relatively short electrode skin di tance (1 or 2 cms ) no harmful ri ing of the temperature through clothing need be feared, in fact in thi case the clothing cause a heat in ulation which may be an advantage If the feet are included the shoe must be removed as leather or a y metal part would cause strong additional heat effect

***Treatment oft the Extremities by coils.*** Kowarschik intro duced thi new method which i known as Coil Field Treatment A metal band embedded in thick in ulation of specially prepared

rubber is wound round the extremity in question to form a coil the ends of which are connected to the Short Wave apparatus. Owing to the high inductive resistance to the high frequency current the current intensity in the windings is very low and an electric field is produced most of which flows between the outer windings of the coil and goes through the body or part underneath. The electrical effect therefore is somewhat that of two ring shaped condenser electrodes laid round the extremity; the apparent effect is a fairly high degree of heat which can be very efficiently modified according to whether deep or superficial effect is desired. A very good depth effect can be obtained and depends on the distance of the coils from the skin and the respective distances of the coils from each other. This method can be used to produce an extremely efficient form of Artificial Fever Therapy; in that case the coils are wound round the trunk. The patient is unclothed and covered by blankets with a folded blanket under him.

**Superficial Treatment (Surface Treatment).** In treatment of skin diseases or superficial wounds the active electrode is placed over the affected part and the skin-elektrode distance is at least 1 cm. To insure homogeneous skin penetration; anything under 1 cm must cause harmful point concentration on small creases, pimples and other defects of the skin.

If swelling or contusion be present the electrode distance must be increased accordingly. The greater this distance the more homogeneous and even is the effect. Inclusion of Carbuncles and Abscesses and opening out of wound areas should be avoided if possible, as interference of this kind greatly impairs the effect of Short Wave Therapy.

In treating wounds the dressing, whether dry, wet or with ointment, should be removed as these things may cause additional heat effect and burn. The cases are best treated with bare skin, with Schliephake electrodes and a free air distance between them and the skin which completely avoids contact with the wound or injured part. The indifferent electrode should be of the same size or rather larger than the active one.

**Monopolar Treatment** as in fig. [illegible] is permissible here when penetration is not of importance.

**Dosage and Treatment time (Hand test)** Dosage must depend to a large extent on the patient's subjective heat sensation, if this should be disturbed, dosage can be determined, more or less accurately by the Practitioner himself placing his hand on the patient's skin. In making this test the Short Wave apparatus must be switched off to avoid sparks and burns between his hand and the skin On removal of the hand, the apparatus is switched on again A moderate dose would naturally be given in such a case, and, adjusted by sensation voltage, size and distance of the electrodes, and, above all, by the results of previous experiences If the patient's heat sensation is abnormal it is wiser to work with rather lower dosage than usual, the time of exposure can then be somewhat increased Even with a maximum dosage, t h e r e s h o u l d b e n o t i n g l i n g o r d i s a g r e a b l e s e n s a t i o n, t h e n o r m a l a n d s u i t a b l e d o s e i s j u s t t h a t a m o u n t o f e n e r g y n e c e s s a r y t o p r o d u c e a g r e e a b l e w a r m t h With some patients warmth sensation diminishes during treatment although dosage has remained constant, in others, it increases so that it is often necessary to decrease the dosage after a little while

The use of measuring instruments (current indicators) for adjustment of the dosage is somewhat restricted and serves only the purpose of supervising the constancy of the adjusted dosage, or its r e l a t i v e alteration Absolute dosage values can no more be measured in short wave therapy than they can in long wave diathermy where the sensation of heat governs the dosage

It would seem that the field explorer or sound described on page 76, equipped with a measuring instrument for controlling the dosage might prove useful for measuring the field intensity when it is placed between the electrode and the patient. But investigations in this direction have shown that the indications of this instrument depend much on the size and the form of the electrode on the electrode-skin distance on the intermediate layers and on the individual characteristics of the patient, so that the indications of the instrument and the heat sensations of the patient do not coincide Therefore o b j e c t i v e adjustment of the dosage ist so far impossible Other method based upon direct temperature measurement of the skin are under trial.

The use of mercury thermometers m a y r e s u l t in local field concentrations and give incorrect measuring results in these cases, especially when the mercury strip lies more or less parallel to the field line direction. Relatively correct current indications should be obtained when using quartz thermometers filled with benzole (1).

(1) See Supplement page 197

Experience has shown, however that the normal dosage applied to the patient in most cases does not come near reaching harmful dosage so that, generally speaking determining dosage according to the subjective heat sensation method usually fulfills the requirements of practice It is by no means as necessary in short wave therapy to determine dosage as precisely as must be done in X Ray therapy

The exposure times usually applied amount to about 10 to 30 minutes and their average values are 15 to 20 minutes approximately One treatment per day is the rule Particular circumstances may require two treatments per day, or treatment may be decresed to every two days or even longer pauses may be advisable

## 2 *The structure of the field as a function of electrode arrangement*

For obtaining a good treatment result it is of the highest importance to arrange the lines of force of the field inside the body run so that their maximum density coincides with the affected organ or part that they penetrate The structure of this field can be influenced by suitably arranging the dimensions form distance and position of the electrodes

As it is scarcely possible to give special prescriptions as regards the most advantageous electrode arrangement for each individual treatment case we must be content to determine approximately suitable field line structure which would penetrate the affected part and to arrange the electrode accordingly

This calculation presupposes for certain typical electrode arrangement a precise knowledge of the field line spectrum which is represented in the following pages by field line figures available not only for homogeneous media but which serve sufficiently accurately for practice for the heterogeneous substance forming the human body provided however that sufficiently short waves of 6 metre length are used

The longer the wave the more the field line will deviate similarly to the characteristic condition prevailing in long wave diathermy (see fig 81 c, owing to the low capacitive penetration power of the longer wave bad conducting layer and encapsuled part will be passed over by the current forming loop around instead of penetrating them in the shortest way and so creating a good depth effect

Generally speaking, the distribution of the heat which is *felt will* enable us to verify with sufficient accuracy wether the electrodes are suitably arranged or not, but in depth treatment sufficiently large electrode distances must be provided as heat sensation has its seat on the surface layers.

Once more we must refer to the fact that with reduced electrode skin distances a heavy surface heat can be obtained with a totally deficient depth effect.

It should be noted that not only electrodes but cables produce a field energy that may result in undesirable heat effects if touched. Therefore contact between patient and cable must be prevented by insulating materials. The cable field is not homogeneous throughout its length and disappears at certain points (voltage nodes). This can be shown by passing a neon tube along the cable. It does not light up at the voltage nodes but shows its maximum brightness at the anti nodes. Two wires of sufficient length, connected at the ends and running parallel at a distance of 10 to 20 cms (Lecher wire system) connected to the poles of short wave apparatus would indicate the voltage nodes of half wave lengths of the apparatus. A simple device for measuring wave lenghts without a wave meter is based on this principle.

**Typical field line figures.** To ensure the most suitable position of electrodes it is as well to memorise the electrode positions and figures given below and to bear in mind that heat development is proportional to the square of the strength of the condenser field so that any unevenness or inequality in local heating effects is often greater than the density shown by the lines of force. Also one should remember that in the figures conditions are more or less idealised and applied to material of homogeneous substance (¹). In the heterogeneous tissue of the human body the heating effect depends a good deal on the [illegible] tissues.

But on the whole these figures are of valuable assistance in practice and show clearly the most efficient arrangement of electrodes with regard to the distribution of the lines of force and heat.

A[illegible] experiment for proof of the structure of the field in the various positions of the electrodes, the instrument or field explorer shown in fig. 44 can [illegible]. A glass vessel (or any insulating material) filled with water with [illegible]trical conduction and conforming as nearly as possible to the [illegible]

(¹) [illegible]ut regard to the breaking of the lines of force in the marginal zone.

form of the body part to be treated, i. e., a cylindrical vessel is suitable to show the course of the lines of force in a limb where the direction of the field is transverse. The instrument is introduced from above and must be held so that its condenser plates are at right angles to the direction of the lines of force. On rotating it the correct position will be found by the brightness of the incandescent lamp attached to it. In his "Essai d'Etudes des ondes courtes par les spectres à l'encre de chine" Denier(¹) suggested an interesting method of inspecting the Short Wave field by means of Indian ink. He put a solution of Formol in distilled water into glass vessel, which was placed in the condenser field. When Indian ink was dropped into this, distinct lines within the liquid showed the path of the lines of force. In this way he was able to demonstrate the course of the field obtained by using electrodes of various sizes. We also see a field concentration resulting from placing pieces of metal in the liquid. He insists on the importance of adequate spacing for depth effect and for obtaining the utmost homogeneity of the field, which is clearly shown by his method of testing.

*Typical field line figures*

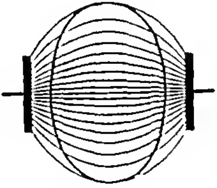


Fig. 45 (Case 1)

**Case 1. Homogeneous penetration with electrodes of equal size and with equal spacing.** This shows how only the central homogeneous part is utilised for penetration. If the distance between the electrode and the skin is reduced, the area of highest density is on the surface causing excessive heating of the superficial layers and very slight depth effect. Density and heating are greatest in the axial zone connecting the centre of the two electrodes. The energy is decreased towards the margin of the electrodes first slightly and then suddenly outside the space limited by them, as may be seen by the shaded area of the figure. If spacing be adequate and the electrode centred exactly over the part to be treated, the heated area exceeds the area actually to be heated. When spacing is

(¹) Denier E. Essai d'etudes des ondes courtes par les spectres à l'encre de Chine. Arch. d'electricite 47th year No 605. April 1935.

adequate, as shown by the shaded area in the figure, the electrode distances correspond to the conditions suitable for trunk treatment with a wave length of six metres and a total therapeutic output of 300 watts If longer wave lengths are used, we get a decrease in penetrative capacity which must be adjusted by working with a reduced output It was found necessary then to arrange small electrode distances which gave less homogeneity and less depth effect The best conditions for penetration are obtained where the depth law is obeyed

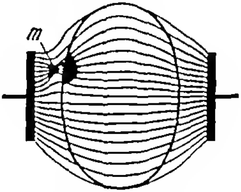



Fig 46 (Case 2)

**Case 2. The piece of metal lying between the electrode and the skin causes field concentration likely to cause local overheating** Therefore metal parts of clothing, pins, hairpins, contents of pockets should be removed or kept out of the condenser field.

The shaded part of the figure represents the unequal density existing at right angles or transverse to the direction of the lines of force. Differences of equality in the longitudinal direction of the field are marked by the different density of the field lines

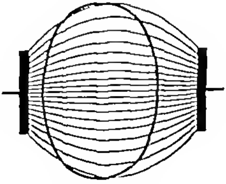


Fig 47 (Case 3)

Case 3 With equal sized electrodes spaced unevenly, concentration of energy takes place at the nearer electrode This results in increased unilateral area density in the superficial layers

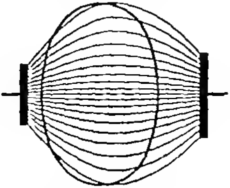


Fig 48 (Case 4)

Case 4 Concentration of energy confined to a small area takes place below the small active electrode Concentration may be increased by placing the electrode at different distance from the body An extreme case of this kind is the application of a very small bare electrode to the skin so that a burning effect is produced (coagulation — electrical surgery)

In certain circumstances field distortion due to some external conducting body or apparatus, unequal potential on the poles of the apparatus or energy conduction from a smaller electrode may occur It can also happen that the field density with a small electrode is no larger than with a larger one and it is possible that the larger electrode may even have greater field density and greater heating effect.

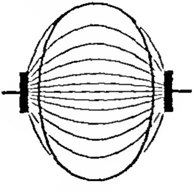


Fig 49 (Case 5)

Case 5 If the electrodes are small compared with the volume of the body in the condenser field there is much dispersion of

energy and a great difference between the density of the skin and that in the centre portion of the cross section The depth effect will then be less in relation to the surface effect than where larger electrodes are used When using small electrodes the effect obtained is more or less restricted to the superficial layer

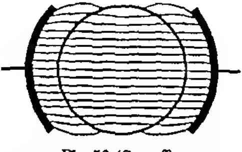


Fig. 50 (Case 6)

Case 6 In transverse or lateral treatment of the limb the diameter of the electrode should be approximately that of the part to be treated The edges of the two electrodes are kept at a wide distance from each other With adequate spacing of some centimetres there will be a good depth effect and an even distribution of energy Better results, however are obtained with Schliephake electrodes as shown in 9 and 11

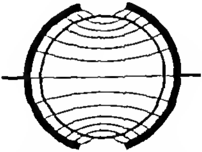
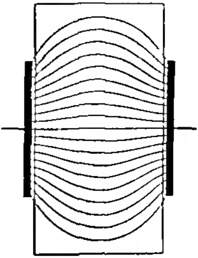


Fig 51 (Case 7).

Case 7 With pliable electrodes that are too large or without sufficient spacing we get a most unsatisfactory distribution of energy The most intensive heating effect is obtained in the surface layers between the edges of the electrode To avoid overheating the energy must be reduced which results in poor depth effect

a

Fig 52 (Case 8)



b

Fig 53 (Case 8)

**Case 8 Flexible electrodes of suitable size but insufficiently spaced** If only a cross section is considered a homogeneous field is apparently produced but a longitudinal section shows much dispersion resulting in insufficient depth effect Kowarschik has proved on the cadavre that in treating a leg the depth effect obtained with pliable electrodes placed on the skin is smaller than that obtained by bare electrodes placed on the skin as in diathermy

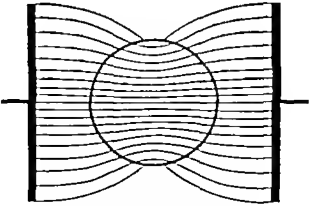


Fig 54 (Case 9)

**Case 9 Lateral or transverse treatment of a limb with large rigid Schliephake widely spaced and without compression.** With this arrangement the field concentration is equal in the limb and energy is evenly distributed with excellent depth effect

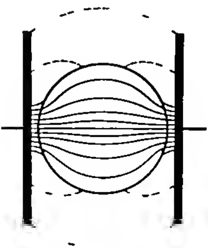


Fig 55 (Case 10)

**Case 10 The same treatment with too close spacing** An unsatisfactory field distribution Too much heat on the skin and little depth effect

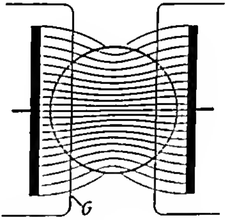



Fig 56 (Case 11) G = glas cylinder or „shoe"

**Case 11 Lateral treatment of a limb with large Schliephake electrodes with compression and sufficient spacing** Concentrations as shown in Case 10 are eliminated as the surface is equally distant from the electrode, and homogeneous energy and a satisfactory depth effect will be obtained. Compression should never be excessive especially where bones are near the surface as otherwise the heat sensitivity of the patient may be impaired and in any case free circulation is impeded.

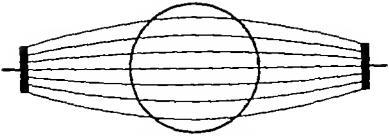


Fig 57 (Case 12)

**Case 12. Lateral treatment with small electrodes and excessive spacing** This gives a very homogeneous field but the capacitative resistances are increased owing to too small electrodes and large distances There is a consequent loss of energy into space from the back of the electrode and no heat is felt in this case

According to Liebesny good therapeutic effects are obtainable even with large distances — so large that little or no heat is perceptible Some explanation, however is necessary as to what diseases or condition this applies and under what conditions it is achieved, as a pleasant and agreeable heat is usually the most favourable condition for success

On the other hand it has been found that treatment given with small electrode distance even smaller than those which apparently should correspond to the wave length and energy applied are successful and that average therapeutic results were improved by arranging for better spacing

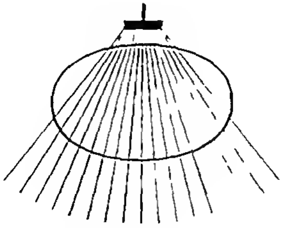


Fig 58 (Case 13

**Case 13 Monopolar treatment.** One active electrode only is used The unused one is replaced by earth and the connection to earth established by placing the electrode on the earthed cabinet

This is a direct earth connection A capacitative connection can be established by putting a large electrode in contact with the cabinet This method, however, is only suitable for surface effect as there is only field density in the immediate neighbourhood of the electrode

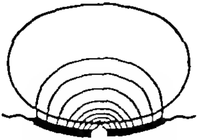


Fig 59 (Case 14)

**Case 14** Electrodes placed close to each other on one side of the body produce an undesired concentration of energy in one spot near the electrodes No depth effect

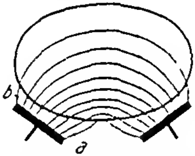



Fig 60 (Case 15)

**Case 15** Electrodes placed on one side of the body obliquely to each other but further apart and with increased distance at A rather than at B This produced a more even field than in Case 14

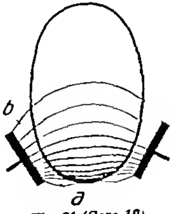



Fig 61 (Case 16)

**Case 16** **Electrodes applied to a sharply curved part of the body with distance A smaller than distance B** There is decreased capacitative resistance and a greater concentration of the field near the lower part of the diagram

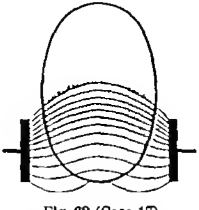


Fig 62 (Case 17)

**Case 17** If under similar conditions the electrodes are **placed parallel** to each other their outer edges lie nearer to the body and if the distance is too small the field is concentrated on to these outer edges with very bad depth effect

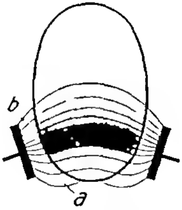



Fig 63 (Case 18)

**Case 18** **By making the distance at A slightly larger than at B,** the field may be made practically homogeneous

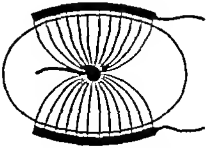


Fig 64 (Case 19)

**Case 19 Metal electrodes in a body cavity such as the vagina** ***always cause concentration*** **of energy even when not connected** ***to*** **the apparatus.** To use only one electrode would produce one-sided concentration and heating Better effect is produced by using two large and separate electrodes connected in parallel

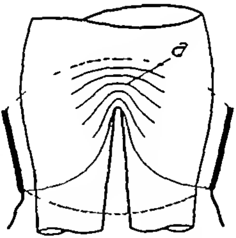



Fig 65 (Case 20).

**Case 20 Electrodes placed on both sides of the thigh.** If the legs are pressed back so that their inner surfaces make a good contact the field will take the form of the dotted lines but if *the thighs are separated even slightly,* there will be concentration and over heating because of the large capacitative resistance of the layer in between causing distortion of the field and concen

tration again, and it is possible that a spark may pass between the scrotum and thigh. Therefore, treatment of both thighs, knees or calves simultaneously is not advisable if depth effect is desired, because small burns may occur, the energy concentrating where the edges touch. This can be avoided by slightly separating the legs and placing felt between them, but that will give a longitudinal heat effect with field concentration at A and the energy will not pass transversely across both limbs.

Fig. 66 (Case 21)

**Case 21. Longitudinal penetration of the leg.** The dotted lines represent the field spectrum in air between the electrodes. Here the field is contracted inside the leg because the dielectric constant of the body is 80 to 90 times higher than that of air. Wide spacing of electrode from foot prevents overheating of foot or ankle and renders penetration of calf at the knee possible. Foot electrode to be kept at a distance of 5 cms. from the floor by dry wood to avoid energy losses due to semiconductors such as wet floors, linoleum, carpets, stones. Distance of pliable thigh electrode of large size .5 to 2 cms.; the electrode adapts itself to the form of the thigh.

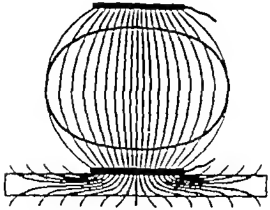


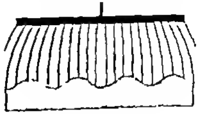
Fig 67 (Case 22)

**Case 22. One electrode placed directly above an underlayer which is a semiconductor produces a field with the disadvantage of additional losses and strong heat effects in this underlayer** Semi conductors are moist materials such as leather, oilcloth, etc

Both electrodes should never be arranged close above a semi conductor on account of the strong heat effects caused by the large quantities of energy which pass through it They should be kept at a distance of 3 cms at least by intermediate layers of non conducting material, dry blankets rubber, sponge, etc

a

Fig 68 (Case 23)



b

Fig 69 (Case 23)

**Case 23 Too narrow spacing** (a) Fig 68 Field concentration at the points near the electrode due to unevenness of the skin (pimples furuncles etc ) with consequent local heating effects so that the output must be reduced Depth effect decreases

(b) Fig 69 **Wider spacing** This equalizes the field density and the heat effect is homogeneous and better depth effect is obtained with increased output of apparatus

## VIII Biological and therapeutic effects of short waves.

Heat and hyperaemia of the tissues are immediately realised and become perceptible Both the e effects are also found in Long Wave Diathermy but are characteristically different from those obtained in the Short Wave field

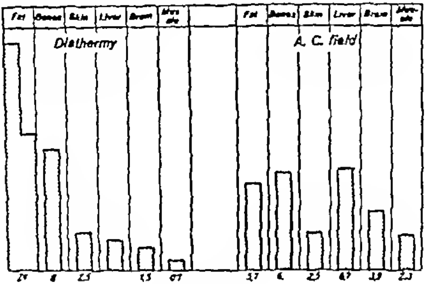



Fig 70

Heating of various parts and tissues by diathermy current and within the field of the 3 metre wave (1)

The extreme heating of fat which takes place in diathermy is reduced in the short wave field With other wave lengths certain displacement of individual tissues and heating occur When living tissues are heated there are also those due to the individual conditions of blood circulation

The inequalities resulting from the heating of tissues by long wave diathermy and short waves of 3 metres are clearly represented in Fig 70 (fat bone skin liver brain muscle) They are subject

1) Verhandlung d. Deutschen Kongresses fur Innere Medizin No 41 1 ... (ur ... 1 pag 298 Bergmann Munich.

to change on modification of the wave length but in the short wave method of treatment there is relatively small heating of fat, which always takes place in long wave diathermy. In practice, however, the subcutaneous fat layer will always be heated to a somewhat higher degree. This results in a natural protection of the inner layers from painful heating.

The hyperaemia produced by the short wave is of really longer duration than the corresponding effect in the long wave diathermy and other heat treatment methods. *Pflomm* has found that this effect lasts for 48 hours after penetration thus proving that other physical principles are involved here than those concerned with only the production of hyperaemia.

An argument which carries conviction is driven home by *Pflomm* who treated two webs of a *frog's* hind legs — one in a short wave field, the other in a hot water bath. On both adrenalin solution was dropped afterwards. The capillaries in the water bath were dilated but the adrenalin immediately reacted on these by a strong contraction. But no influence of adrenalin could be found in the capillaries enlarged in the short wave field.

Figures 71 to 78 represent some of *Pflomm's* experiments. He explains this peculiar short wave effect as due to influence exerted on the visceral nervous system, that is, a reduction of sympathetic and an increase of vagus tonus. Further experiments made with the heart muscle confirm this.

**Anodyne and Soothing Effect.** Another distinct effect of short wave therapy usually found in the first treatment, is the alleviation of pain far more effective than in long wave diathermy or in any other method of physical therapy. There is also a distinctly soothing and agreeable, often soporific, effect.

**Anti inflammatory and Anaphlogistic Effect.** A fundamental difference between short wave therapy and long wave diathermy is the favourable influence the former has upon acute inflammatory and septic processes in which long wave diathermy is strictly contra indicated, because it is apt to activate and spread the inflammatory process.

Schliephake was the first completely to cure severe and even hopeless cases of pleural empyema and lung abscess without operation. He recommends the shortest possible wave lengths when

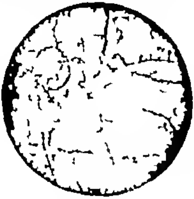


Fig 71

Fig 72.

Fig 71

Vascular system of the web of a frog. Scale 37 : 1 (Pflomm)
Capillaries partially contracted by adrenalin.

Fig 72.

The same treated by short waves of 4.5 metres. No contraction.

Fig 73

Adrenalin treatment has been repeated 1½ hours after penetration. The experiment confirms the constancy of the heat effect by short wave penetration.

septic processes are concerned. The more recent the process the better its reaction to short wave treatment. Later Liebesny confirmed this.

The favourable influence of short wave therapy on inflammatory and septic conditions is partly due to the strong hyperaemia which results in an increase of the natural defensive forces of the body increasing, as it does, the blood flow with more white blood corpuscles with phagocytic action. The absorption is considerably increased provided that the dosage be not too strong (if it is too strong phagocytosis may be reduced).

Schliephake also suggests that there is a certain auto-vaccination due to the dead bacteria. While curing furuncles, he found that several untreated ones healed simultaneously.

Furthermore, there is also probably a direct influence on pyogenic bacteria (staphylococci and streptococci) due to heat effect of more or less subjective character. (Point heating).

Pus evacuated and afterwards treated in a short wave field is found to be sterile in some cases. This is, of course, not the rule always but generally speaking the weakening of the virulence of the bacteria will often suffice for making the activated prophylactic forces of the body counteract the infection.

Schliephake has proved that in the short wave field pus and inflamed tissues are heated up to a higher degree than healing tissues. Pflomm has found that the short wave field gave rise to increased fluid changes between the capillaries and the tissues; this has an influence on the disturbed osmotic processes and furthers healing.

**Lethal Effect on Bacteria.** Schliephake, Haase, Liebesny and others have proved the possibility of killing bacteria in the short wave field by relatively low dosage. This effect is independent of the wave length used.

Schliephake has succeeded in proving the lethal effect on streptococci and the tubercle bacillus when treated for periods of 3 to 8 hours. In these phenomena not only the pure heat effect is concerned. Schliephake proves this by heating to the same temperature bacteria of the same culture partly in the short wave field and partly in a water bath. The period necessary for the lethal effect on the bacteria in the short wave field only amounted to a fraction of that applied to the water bath (see fig. 74 and 75).

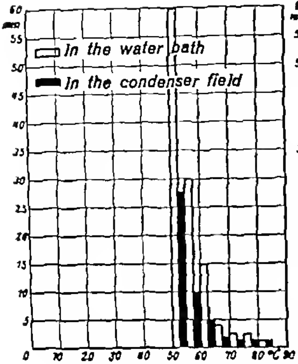



Fig 74

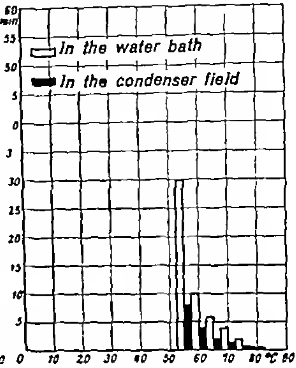



Fig 75

Fig 74

Lethal times of the staphylococci with various temperatures

Part of culture has been heated up in the water bath and part in a 4 5 metre wave both to the same temperature The lethal times obtained in the latter are shorter than those found in the former

Fig 75

Ditto- with tubercle bacilli (Schliephake) Experiments made under the same conditions as for staphylococci.

Hasche and Leunig[1]) on the other hand could not obtain an arrest of the development of bacteria in vitro at blood heat after treatment for 3 to 6 hours They conclude that there are secondary influences which take place within the short wave field on bacteria in vivo Whether the influences of the short wave field on inflamed diseases due to infection are indirect or direct, the important thing is the activation of the natural prophylactic force and the real debilitation of the virulence of the bacteria, which is beyond all doubt confirmed by all writers

(1) Hasché and Leunig D m. W 1935, H. 80 page 1193.

There are technical difficulties in carrying out these experiments, such as the dielectric constants, conductivity and thermal characteristics of the medium. These are all highly important. Also, according to Schliephake the dependency of the bacteria on wave length is not always of the same value though they belong to the same stock. Mutation is also a difficulty. Temperature measurements made in the fluids or in the condenser field respectively only give correct values when certain conditions are fulfilled.

**Influence of different wave lengths.** It is less important to-day in practice to know the different biological reactions produced with wave lengths below 10 m but it should be noted that generally thermal effect predominates with longer waves, while with shorter wave lengths the so-called specific component is largely shown when depth and localising effects have increased simultaneously.

For some years the 6 metre wave length has been found satisfactory and is employed for choice. Ultra short waves of this wave length can be produced with valve machines even under heavy load conditions.

**Possibility of Harmful Reactions in the Prophylactic Forces of the Body.** As the reactions of the longer waves on the body tissues are combined with thermal effect there is always a certain possibility of injury to tissues by over-dosing but these dangers are really very much less in ultra short therapy than with long wave diathermy as the electrodes are kept at such distances from each other and from the skin that the dangers are of no importance provided the operator knows the rudiments of technical therapy. Injuries produced by heat on rats and rabbits have always *occurred* under conditions which do not correspond to those prevailing in human therapy. (Unconsciousness of animal, large electrode, heavy energy density.)

A factor which guarantees a good deal of security against injuries is the increased heat sensitivity of the skin in both treatments. The body reacts to over-dose by sudden disagreeable sensations felt in the internal organs (periosteal, pleural, peritoneal pains). These may be considered harmless hints which disappear at once with switching off and do not occur again when treatment is applied with reduced dosage.

Nervous secondary phenomena, malaise impaired sleep ect have seldom been observed and are probably due to individual predisposition If they occur, the dosage should be reduced and pauses made in the treatment of a day or two Patients of this kind should not be encouraged to stay long in the neighbourhood of the apparatus when switched on It is possible to eliminate these effects by screening of the space around the apparatus by means of an earthed wire netting or a folding screen covered with metal foil

Some diseases react at first with a slight increase of pain which might be considered a contra indication Relief and cure are usually obtained if the treatment is persevered with.

There are few real contra indications to short wave therapy Malignant tumours (carcinoma) are a contra indication, according to all experience hitherto obtained. It is remarkable fact that pregnancy has not been found to be a contra indication and no pernicious effects on either male or female generative glands have been discovered The same holds good for the eyes more than this work is being done to introduce short wave therapy into the field of ophthalmology by Gutsch and others

Summarising these effects we can state that the biological and therapeutic effects of Short Wave Therapy are distinctly outlined although the working technique of this mode of therapy has not yet been completely established. The effects produced are entirely different to those produced with other physical therapeutic method such as diathermy and ionization According to Schliephake the differences existing in these methods of treatment are probably analogous to those established between X rays and ultra violet rays

## IX Experiences gained in short wave therapy in various diseases, technique of treatment

The indications in short wave therapy besides the disease suitable to treatment by diathermy, and other thermal methods include many inflammatory conditions strictly contraindicated in diathermy (purulent and septic cases) More than this ultra short wave therapy generally excels diathermy in effect, and cures especially in *acute cases*, in a much shorter time

In the following chapter we shall give details of experiences gained with the most important diseases for the general practitioner who will thus have an outline of the possibilities of application of this mode of therapy, and some guide towards the acquisition of a good technique

We have already referred to the great importance of electrode technique and recommend a full use to be made of the directions given in the following chapter remembering that treatment methods described may often be modified, and improved in special conditions

It is the experience gained by the practitioner himself lasting over a sufficiently long time which enables him to become a skilful exponent of short wave therapy

*Strict and exact instructions can only be given in a few cases*

There are very varied possibilities of arranging electrodes including position at oblique angles to the skin but the *field line spectrum can be adapted to almost any condition*. If obliged to work with insufficient electrode distance because the apparatus in hand has a small energy output or the wave length be too long one must give up all idea of reducing treatment time and thus improve the therapeutic effect

To experiment on patients for proving a special electrode arrangement in order to observe the local distribution of heat i only recommended with such patients who are able, by their intelli gence to give correct indications of heat sensation By far the best method is for the practitioner to test these methods on his own body

## 1 *Furuncles and Carbuncles*

Schliephake refers to over 300 cases of Furunculosis more or less extensive with only one failure (due to simultaneous self treatment by ointments plaster, etc) All his other experiments are very favourable

Average treatment time four to six days with one treatment per day including severe cases where other large furuncles not actually treated were simultaneously cured.

Single furuncles have been cured within two to three days as a rule moderate doses were given with a gentle agreeable warmth sensation Too heavy dosage results in bluish red discolouration of the tissues and prolongation of treatment time up to ten day

Schliephake and Liebesny consider this inflammatory reaction appearing after short wave treatment (Haase and Lob) due to wrong dosage

Average treatment time 10 to 15 minutes 30 minutes in case of carbuncles

Furuncles in process of formation with inflammatory infiltration will retrogress within two or three days if already breaking down irruption will take place in most cases after the first treatment when necrosing thrombus is cast off whereupon healing starts rapidly

Even in cases of furuncles of the upper lip and nose the best results are obtainable Liebesny mentions sixty case of this kind all succesful but one in which meningiti had already occured

In treatment of carbuncles the results are so good that cure may be expected in almost any case Incision should be avoided if possible

Depth effects are not always necessary in these cases so that short wave diathermy (spark-gap apparatus), can be used in the treatment of

furuncles, with due care to the technique to be observed with these apparatus of small output But, it has been found that with spark-gaps it is not always possible to avoid incision as it is with valve apparatus.

**Treatment technique of furunculosis.** A Schliephake electrode of 4 to 9 cms in diameter is fitted to the holder so that the glass bottom of the electrode does not touch the furuncle (see fig 76) Spacing 1 to 4 cms For treating small furuncles a special electrode without a glass bottom is also recommended (Fig 39)

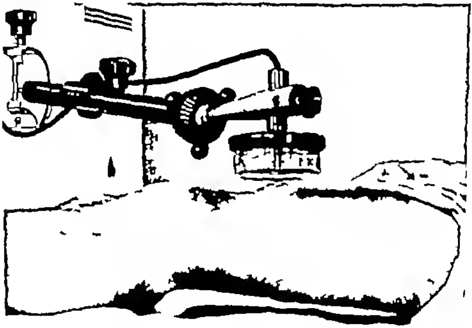


Fig 76
Shows good spacing and no contact with the skin An indifferent pliable electrode — 18 × 27 cms is placed under the thigh with spacing of 2 to 3 cms

When treating furuncles of the face pliable electrodes and bandages should always be avoided Rigid electrodes must not touch the skin and the spacing must be large because the unevenness with reduced spacing causes harmful heat and heterogeneous energy distribution. When using sufficiently short waves — 6 metres — and convenient outputs it is always possible to arrange such good spacing that a homogeneous, gentle heat sensation is felt in the part treated

## 2 *Axillary Abscess (Hydroadenitis)*

Good results have been found here Cases that have resisted some time were completely cured in a very short time In order to avoid relapse it is best to continue treatment until the disappearance of all infiltrations has taken place

Fig 77

Fig 78.

Fig. 77 and 78 Show fair treatment results after six penetrations (P 1 1 o m m)

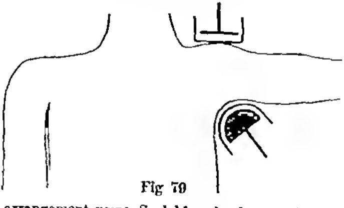


Fig 79

Electrode arrangement using S c h l i e p h a k e special electrode for this condition

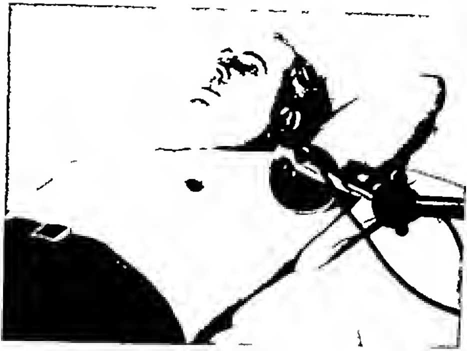


Fig 80
Treatment of hydroadenitis with Schliephake glass-bowl electrode with free air space of approx. 2 to 3 cms Pliable inactive electrode 18 × 27 cms with approx. 3 cm. skin distance

Short wave therapy has proved its superiority over X Ray therapy here even in very severe cases In nine cases treated by Schliephake cures took place in three to thirteen day average time eight days One treatment per day of 20 minutes

**Technique.** Special electrode (see fig 40) with indifferent rigid, or pliable electrode above shoulder (see fig 79 and 80)

### *3 Whitlows and paronychiae*

Fairly good results are reported including case where surgical treatment with many incisions did not avail. Even in severe case operation can generally be avoided Pain is relieved rapidly the sequestration process is hastened, when treating bones Healing start rapidly after the removal of sequestra

Treatment about 20 to 30 minutes per day every day then, every other day

**Technique** The finger (for choice the whole hand) is placed between the Schliephake electrodes spacing of 1 to 3 cms Pliable electrodes can also be used in which case the electrode edges protruding beyond the fingers should be kept apart to avoid field concentration and intensified heat

The good results obtained in the cure of the diseases mentioned under 1 to 3 are confirmed by Schliephake Liebesny Kowarschik Last, Stieboeck Capaldi Pflomm, Nagelschmidt and others Schliephake says "That with a number of several hundreds of cases of this kind only three needed subsequent incision and that recurrences are extremely rare in short wave therapy

### *4 Dental conditions treated by short waves*

Schliephake states that the majority of cases of paradentosis are favourably influenced and results obtained after a few treat

Fig 81

Irradiation of all teeth with spacing of 1.5 to 4 cm Front teeth receive less intensive treatment with this arrangement because the jaw bone and teeth on one hand and the soft parts on the other are traversed in parallel so that the soft parts get more intensive treatment

[illegible] Short Wave Therapy 7

ments He used waves of 8 to 14 metres and got still better results with wave lengths of 8 to 6 metres than with those above 6 metres.

To obtain lasting effects it is necessary to find the cause of paradentosis, and good dentistry must be done at the same time as well as medical and constitutional treatment Granuloma react well, provided that re-infection from the tooth root canal is prevented

Fig 82

Shows penetration of front teeth with small active electrode — 4 cm. diameter — with 1 to 1.5 cms. spacing By this arrangement the soft parts and teeth are in series connection as regards the current flow so that the teeth substances and bones get the best effect from the treatment as compared with the parallel connection of fig 81 The indifferent electrode 9 cms diameter has a spacing of 2 to 4 cms. from the cheek so that only slight warmth is felt here With this lateral position the active electrode must by sligthly displaced to get homogeneous heat effect.

Gumboils and other purulent processes are very good indications for short waves also lymphadenitis lymphangitis and periodontitis Pain ceases after the first treatment in many cases Short wave therapy also prevents pain after extractions Rheumatic diseases of the jaw Sinu iti , Antrum infection Ethmoiditis and facial neuralgia are al o indication for short wave

therapy. T e c h n i q u e is important, also wave length and energy output are decisive factors.

Liebesny had very good results in the treatment of peri odontical inflammation, granulomata, etc., working with waves of from 4 to 6 metres.

**Technique.** Schliephake electrodes of 4 to 9 cms. diameter used with spacing of 1 to 4 cms. (see figs. 81 to 89). B a n d a g i n g of

Fig. 89.
U n i l a t e r a l t r e a t m e n t o f t e e t h with an active electrode of 4 to 9 cm. diameter and spacing of 1 to 1.5 cms. Inactive electrode 9 cms. diameter with spacing of 2 to 4 cms.

the pliable electrodes to the body is n o t r e c o m m e n d e d (unhygienic perspiration, overheating and decreased depth effect).

Too small electrodes should not be used as the narrow spacing necessary here to get complete resonance results in heavy losses of energy within the body and bad depth effects.

Also the hyperaemia produced within a small area is less constant than that produced on larger body part.

N o m e t a l p a r t s must be touched by the patient during treatment. Wooden chairs with adjustable head support that unscrew are the most practical means of supporting the head and preventing accidental touching of metal part.

## 5 *Purulent conditions of antra and sinuses*
### *(Pneumatic cavities)*

These conditions are very well suited for short wave treatment, and it often does away with the necessity for operation

Acute and septic cases react almost immediately but chronic cases require more treatment — 10 to 20 sessions Permanent healing is not as a rule obtained as the mucous membrane has been

Fig 84

Penetration of the pneumatic cavities with an active Schliephake *electrode (4 or 6 cms dia., skin distance approx. 1 to 3 cms.)* and an inactive pliable electrode 18 × 27 cm underneath the head

roughened and thickened and often permanently injured *But if* relapse takes place a very few treatments usually suffice to get over them and one can at lea t promise freedom from symptoms for a long time

More or le severe headache and sensations of faintness have sometime been observed after the first treatment *or two* thi requires a reduction of dosage and a different placing of electrode avoiding penetration of the brain itself

The change from purulent to mucous discharge in a few cases announces the beginning of healing process in acute cases. In chronic cases however it is difficult to clear up the mucous discharge which often becomes almost permanent, although symptoms often disappear.

## 6 Diseases of the upper air passages.

Acute colds can often be completely cured in a day, the symptoms appear to disappear after the first treatment. The same results are obtained in cases of acute laryngitis, hoarseness often disappears after the first treatment.

Fig 85

Position of Electrode in the treatment of Colds.

The spacing and the angular position must be so chosen that an even feeling of warmth is produced in the nose and its surroundings. Larger electrodes are also advisable in order to penetrate the antra, spectacles must be removed.

Septic and chronic laryngitis with chronic catarrh, where every kind of cure at Spas have been tried in vain, have been treated with best results.

Many authors confirm the excellent results of short waves in catarrhal conditions In acute cases a few treatments completely clear up the condition

**Technique.** Pliable electrodes with felt underlayers are not advisable for the face, but can be used for the throat a well a the glass Schliephake electrodes For difficult and chronic cases the latter are the best with big spacing of 1.5 to 4 cms *Technique* for Cold (see fig 86)

Fig 86
Penetration of larynx with two Schliephake-electrodes of 4 cms. diameter and 1 to 2 cms spacing The electrodes are placed at an angle to each other

## *7 The Ear*

Septic otitis media The result depends largely on the stage acute processes give the best reactions If pus collected behind the tympanic membrane di charge incision i necessary Secondary suppuration then cea es rapidly in period varying with the more or le s acute character of the condition

Serous otitis media generally inclines to relapse Good re ults have been obtained in the treatment of otosclorosis ear

furuncles catarrh of eustachian tubes (Lux) even in chronic cases of atresia

Dizziness may be felt during or after treatment, but disappears in about 10 minutes, and has never led to any harmful effects It is well however when treating sensitive patients to treat each ear separately with the inactive electrode on the opposite

Fig 87

Unilateral penetration of the ear with Schliephake electrodes of 4 or 9 cm. diam. over the auricle with approx. 1,5 to 3 cms skin distance Inactive electrode of 9 to 13 cms diam. with approx. 3 to 5 cms skin distance

cheek this prevents the field from passing through the large portion of the cranium

**Technique.** Schliephake electrodes of 4 or 9 cms diameter are fitted to the pinna, or to the petrous portion of the temporal bone Compression of outer ear against the bone is desirable as it prevents sparking between the auricle and skull Spacing of 1.5 to 3 cms The inactive electrode — 9 or 13 cms — is placed on the opposite

cheek, with spacing of 2 to 4 cms so that very slight warmth is felt beneath this The patient should be treated either in recumbent position or in a chair with head support, introducing an olive shaped electrode (diathermy electrode) into the outer auditory meatus is also good, pliable electrodes are not recommended because of the drawback of bandaging

## 8 Diseases of bones and joints

Periostitis responds well to short waves Lasting cures of epicondylitis of the elbow joint with radiating neuralgia and weakness of the arm as well as periostitis of the os calcis due to calcification of the joint often cured in about 6 to 12 treatments

Local short wave treatments of polyarthritis are ineffective but reliable results, as far as freedom from pain and restoration of joint function go, are obtained by treatment by a moderate degree of fever treatment than by medical local treatment, but, focal infections of teeth, tonsils, etc., must be treated at the same time The same applies to spondylarthritis.

*Good results have been obtained in the treatment of* mon arthritis persisting after polyarthritis

Effusions into the joint that have lasted for years are gradually absorbed Diathermy and other thermal treatments have often been pushed up to the resorption process in 5 to 8 treatments although in some 10 to 15 treatments are necessary

Septic and chronic arthritis is often alleviated very rapidly as regards function of the joint and the general improvement of the patient Inflammation of the knee joint has often responded so well to one treatment that actual recovery has taken place

Even in cases of chronic knee joint inflammation with deformity and boney out growth pain can be alleviated, and even stopped and function can be restored The X Ray picture may not give visible proof of the improvement but the recovery of function is a very real proof in view of the fact that all other methods of treatment have failed in these cases

In these cases the best heat effect is got by applying fairly strong dosages giving just that amount of heat that can be born without any discomfort or pain

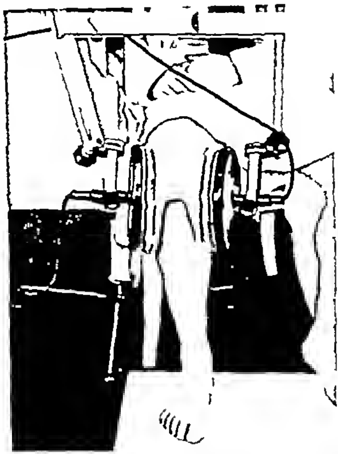


Fig 88

Vertical penetration of the whole knee joint by means of Schliephake electrodes of 18 cms in diameter with skin electrode distance of about 3 to 5 cms The electrodes are slightly pressed against the knee by a rubber band which is attached to the electrode holders The tension of the band is adjusted by means of a clasp Optimal depth effect can be realised with this arrangement.

Very good results have been obtained in the treatment of gonococcal arthritis

Pflomm reports that restituo ad integrum can be obtained which he verifies in the joints before and after treatment

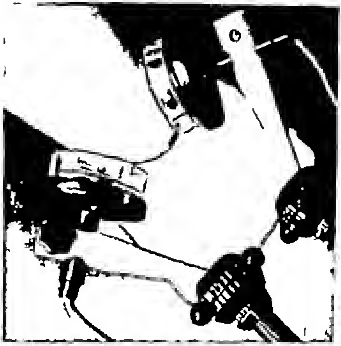


Fig 89

Transverse treatment of knee by Schliephake's electrodes of 9 cm diameter with skin-distance of 1.5 to 3 cms. (see fig. 91) by this arrangement the most intense effect is on the patella, if electrodes are arranged at the correct angle as in the figure

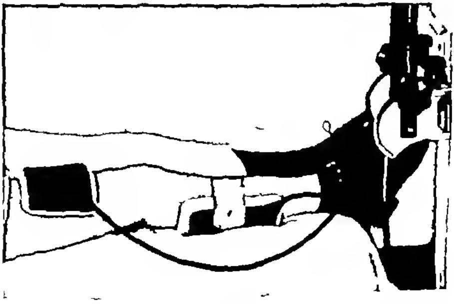


Fig 90

Longitudinal treatment of the knee with pliable electrodes, 18 × 27 and spacing of 1 to 2 cms here the maximal heat effect is on the soft parts

**Cures of osteomyelitis by short wave treatment.** Schliephake succeeded in getting complete retrogression of the inflammatory process in early cases whereas yet the X Ray pictures showed no bony change temperature swelling and pain disappeared in a few treatments in more advanced cases the formation of sequestra was hastended so that an operation afforded a better prospect of success In the treatment of traumatic joint

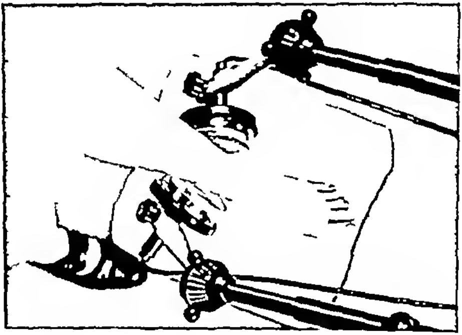


Fig 91
Transverse treatment through the ankle joint with Schliephake's electrodes of 9 cms diameter and spacing of 1.5 to 3 cm. If there is much tendo vaginitis the more intense heat can be applied to the achilles tendon by placing the two electrodes at a suitable angle to one another

diseases due to injuries from sport etc., with bloody and serous effusion into the joint the writer has obtained total resorption of effusion and retrogression of the inflammatory process and complete mobility of the joint Lux and Last also report favourable result and lay stress on the very rapid alleviation of pain and discomfort and the extremely rapid resorption of effusion The pain soothing properties of this method of treatment allows of the much earlier application of massage and movement

**Technique of treatment to insure reliable depth effect** The cases depicted in figs 54, 56, should be carefully studied, also case 8, fig 50 In these cases electrode skin distance of 1.5 to o cms are recommended A few typical methods of treatment are also given in figs 88 to 92

Fig 92.
Longitudinal penetration of the foot and the anklejoint with two pliable electrodes 18 × 27 cms with approx. 1 to 8 cms skin distance

## 9 Rheumatic conditions.

Treatment of rheumatism shows favourable result even refractory cases treated sometimes for years by other thermal methods with little or no success habe been cured by short wave therapy after comparatively few treatment

*Lumbago.* One treatment of ten to twenty minutes will certainly relieve and in some cases remove all pain and even in severe cases a complete cure can usually be effected.

*Sub-acute muscular rheumatism.* Pain and disability very soon disappear. This shows the superiority of short wave treatment to diathermy in the treatment of these tedious rheumatic affections. For a complete cure, however, it is absolutely necessary to consider and remove all *sources of focal infection.*

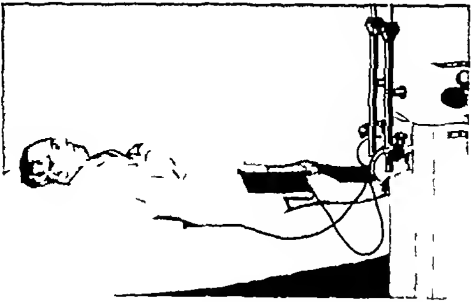


Fig. 69.

Longitudinal penetration of the thigh for sciatica with two pliable electrodes 18 × 27 cm, with approx. 1 to 3 cm skin distance.

**Technique of treatment.** In carrying out transverse or lateral treatment through a limb both Schliephake and pliable electrodes can be used but the latter only if treatment is given in a longitudinal direction. If treatment of the whole leg is indicated it is well to do it in two sections, first through the thigh and then through the leg, as otherwise the path of the current is too long for treatment to be effectual.(1)

(1) Schliephake: Treatment of rheumatic and arthritic conditions with short and ultra short waves. Balneologie 193[illegible].

Kowarschik's three electrode method as used in long wave diathermy is that of placing one electrode on the dorsal region, the second above the ankle and the *third above* the knee is also possible but not so good as short wave therapy because it is difficult for physical reasons to obtain a good resonance and tuning effect

If the apparatus has more than one wave length, it is advisable to select a longer wave length for the longitudinal treatment of the leg This definitely decreases energy loss

## *10 Inflammatory conditions of the peripheral nerves.*

Experience has given results in the short wave treatment of *sciatica of by no means unanimous character Complete failures* occasionally take place as well as *excellent results* but, in view of the fact that Schliephake and others have succeeded in curing this very intractable condition by electropyrexia or even by strong doses from an apparatus of high energy output it is perhaps justifiable to attribute *most of these failures either to unsatisfactory technique or to low energy output.* As a rule *acute sciatica* react best In *chronic cases good results are often achieved* by a combination of short wave therapy with medical or possibly other electrical treatment or with ultra violet radiation. Short wave therapy is however much more effectual than diathermy as many cases *that* have failed to react to the latter have cleared up on short wave treatment Occasionally this treatment has produced some increase of pain at the beginning This however is not a bad sign and generally the case that began rather badly if persevered with, results by *completely clearing up* but in cases of this description it is advisable to avoid all exaggerated heat effect If using pliable electrodes very adequate spacing must be arranged for The *electrodes should be large — 18 × 25 cm, and these* can be placed over a certain amount of clothing

**Treatment of neuritis and neuralgia.** This again is more successful if given in the *acute stage* Complete relief has been given in the case of neuritis in the arm and leg after about eight treatments The same result has been obtained in *intercostal pain*

with involvement of the nerve roots. Dosage in these cases must be strictly individual and, as a general rule, moderate dosage is indicated in nerve conditions.

**Technique of treatment.** In sciatica a variety of methods may be employed. In fact this is essential. If one method shows little or no result another may. As stated above, if the whole of the limb is treated by the longitudinal method it is advisable

Fig. 94.
Penetration of the entire arm for neuralgia of the arm with two pliable electrodes 12 × 18 cms, with skin-distances of approx. 1.5 to 2.5 cms.

to treat the thigh and then the leg separately. Fig. 93 shows a treatment of this kind. In some cases, however, treatment of the thigh only is enough. If the pain is not very severe one electrode may be placed on the root of the sciatic nerve and the other opposite.

Another method of treatment is to give it in the sitting position, the current passing from the root of the nerve to the back of the thigh. In other cases lateral treatment in different sections is more effectual, although it takes up much more time

and should really only be resorted to where the apparatus is of such low output that it does not allow of successful treatment of the whole nerve in one

Treatment of neuralgia of the arm is depicted in fig 94 If the forearm is treated, one electrode is placed on the upper arm obliquely opposite the active electrode while the hand rests on the table It is important in these treatments to avoid waste of energy and the arms and hands should never rest on the body

Should both arms be affected, the patient s hands should rest on the table and both electrodes be placed on the forearms only *This ensures a maximum amount of energy to the arms and* a minimum to the thorax owing to the size of the cross section of the latter Here again the electrodes must not touch the body as energy will be dissipated In this case a fairly high energy output is necessary as the path of the short high frequency current is a long one Should this method result in too intense heat production on arms and thorax, the arrangement shown in fig 98 may be employed for the treatment of both arms The electrode arrangement should be carefully studied and electrodes chosen of the right size and right skin distances in order to avoid unevenness in the heat effect

## *11 Diseases of the central nervous system*[1].

**General paralysis of the insane.** Good results have been obtained by general treatment of the whole body (electro-pyrexia), also by treatment of the skull This same treatment has succeeded in banishing the lancinating pains of tabes dorsales Schliephake has had success in treatment of abscesses of the brain and has cured several One woman was cured of daily epileptic fits from compression of the left ventricle from inflammatory change The fits completely ceased after four weeks treatment — 4 metre waves were used Partial recoveries have taken place in encephalitis and Rechou has had lasting results in a case of poliomyelitis The results obtained by the treatment of multiple sclerosis have not been satisfactory

(1) Schliephake Short wave therapy second edition 193

## 12 Skin diseases

Eczema of very varied aetiology reacts well to Short Wave therapy and, according to Schliephake has often been cured after two or three treatments Obstinate cases, that have been refractory for years to every other kind of treatment take several weeks to cure Réchou considered that generalized eczema could be treated with great success

Erysipelas is often cured by one treatment only Liebesny succeeded in curing several severe cases in two or three treatments and these had relapsed several times before

According to Weissenberg herpes zoster reacts well to Short Wave therapy the vesicles dry up very rapidly and the regional pain which generally lasts for at least a month afterward is rapidly cured.

**Technique of Treatment** In the treatment of these skin conditions the depth rule need not be observed An apparatus of small or moderate output will suffice but if extensively affected skin areas are to be treated in one sitting more powerful apparatus offers a better chance of success If a large skin area has to be treated in parts it is often possible to arrange the electrodes with such large skin distances as to give a wider distribution of energy and thus cover a wider area Details of treatments which are applicable here are given in Schliephak s book — Short Wave Therapy 2nd Edition 1935

Raab reports success in treatment of skin conditions by u ing the spark gap apparatu There of course pliable electrodes must be used and these should be bandaged on to the skin with or without spacing which may cause mechanical stimulation and be less agreeable to the patient.

A a rule in the treatment of skin diseases it is always best to avoid any contact with the affected part and the best method is to use Schliephake electrodes which should be fitted to their holder with metal plates touching the bottom of the glass cover Thi di tance can of course be adju ted according to the size of the electrode to about 8 cms from the skin (See Fig 76)

If the skin in any of these case i covered by dry or moi t bandages the short wave effect will be impaired by the additional heating effect which will ari e Expo ure time varies in these cases

from 10 to 20 minutes and can be increased to 80 minutes in chronic and refractory conditions

The skin only requires moderate dosage If any inequalities of the skin are present, *adequate spacing* is very necessary in order to get homogeneous penetration The sensation of heat should only just be perceptible. In using valve apparatus, monopolar treatment is often quite adequate.

### 13 Gonorrhoea in the male

Here treatment of the affected mucous membrane is as a rule ineffective Gumport ([1]), however, reports favourable results, while Nargell and others were doubtful of the success of their treatment As a rule the treatment of infiltrated areas is successful Acute epididymitis is generally curable after a few treatments, alleviation and even complete freedom from pain being rapidly achieved

As in all acute inflammatory conditions, moderate dosage is the rule *with only a comfortable sensation of warmth*

Residual infiltration gives less satisfactory response but can be cured if treatment is regularly persevered with

Acute prostatitis reacts well to Short Wave therapy

**Technique of Treatment** Gumport advises placing the penis between two Schliephake electrodes To treat the ureter throughout its whole length a bare electrode should be introduced into the penis as indicated by Börner and Santos in *Long Wave* diathermy A large indifferent electrode is applied to the perineum and anus with intermediate felt layers and spacing of 2 to 3 cms so that good resonance results For epididymitis a Schliephake electrode of 13 to 18 cms. placed at a distance of 3 to 5 cms above the scrotum which is raised up by some convenient arrangement of underlayers Contact with the scrotum should be carefully avoided A large pliable, inactive electrode is placed under the perineum and anus with felt layers of such thickness that the heat effect is much modified The best way of

(1) Gumport Treatment of Gonorrhoea with Short Wave Therapy Med. Welt 1933, N 10.

connecting up the indifferent electrode is to place a large Schliephake electrode of 18 cms under the treatment table or folding chair (Fig 36)

According to R a a b, the treatment of epididymitis can be done successfully with Short Wave therapy but the necessary application and bandaging of the pliable electrode to the swollen and sensitive scrotum is painful.

P r o s t a t i t i s may be treated by using a bare diathermy prostatic electrode placed over the abdomen at 3 to o cms from the skin. Better and more agreeable to the patient is to penetrate directly the prostate between two Schliephake electrodes of 9 and 13 cms., or else by using pliable electrodes and skin distances of 2 to 4 cms The patient is recumbent with legs apart One electrode above the anal fold, the other above the symphysis pubis so that surfaces of the electrodes lie at convenient angles to one another

## *14 Gynaecological diseases*

In the majority of cases experience shows that Short Wave treatment i successful and both acute and chronic inflammatory conditions are indicated for treatment in the Short Wave field. Complete cure and recovery is obtained in cases of p a r a m e t r i t i s pelvic p e r i t o n i t i s acute and chronic a d n e x i t i s and in many inflammatory t u m o u r s o f t h e a d n e x a Excellent effects are also obtained in deep-seated p e l v i c n e u r a l g i a also in d y s m e n n o r r h o e a and even in c l i m a c t e r i c h a e m o r r h a g e

It appears that the technique of treatment and dosage which must be adapted to the individual case greatly influences the course of the cure The same applies to the energy output because from a physical point of view the penetration of these organs imbedded as they are between large masses of fat and bone in the pelvis presents some difficulty

In some cases the writer has found Schliephake's vaginal electrodes efficient and satisfactory but in the majority of cases penetration right through the pelvic wall on one side is generally preferable

I n f l a m m a t o r y t u m o r s o f t h e a d n e x a are reduced in size and the patient greatly relieved from pain and other symptoms in

6 to 8 treatments, provided the output of the apparatus is high. Later penetration confirms the measure of recovery reached.

**Adnexitis** due to gonococcal infection reacts well to Short Wave therapy. **Vogt** (1) succeeded in removing symptoms and restoring patients to ordinary working capacity even in chronic cases.

There are a few special cases that require a more moderate dosage. During menstruation there is a tendency for *acute* and *sub-acute* inflammatory conditions to become more intense. To avoid this Raab recommends continuing the treatment during the menopause, but abnormally heavy periods are, of course, a contra-indication. At first treatment should be limited to 15 mins and then increased to 30 mins. One treatment per day. *When treating gynaecological conditions it is very necessary to take into account and closely observe the bodily and psychical condition of the patient.*

**Technique of Treatment.** For the above conditions, Schliephake electrodes (Fig. 41) or a bare diathermy electrode can be used in conjunction with one or preferably two large or medium sized indifferent electrodes placed at skin distances of 2 to 5 cms.

If **two indifferent electrodes** are placed one under the coccyx and the other on the abdomen, the result is a good and homogeneous field (Fig. 64.) Only one is used if penetration has to occur directly through the adnexa. In order to get suitable penetration of the uterus and adnexa the electrode placed underneath the coccyx must be arranged according to **Kowarschik's** Figs. 95 and 96, so that the lower edge of the electrode reaches the tip of the coccyx. A second electrode of equal size is then placed over the abdomen. A strong depth effect is necessary here in spite of the thickness of the part. Schliephake electrodes of sufficient size and spacing 1 to 7 cms must be used corresponding to the output of the machine. The patient lies on the side or on the treatment table (Fig. 86). The latter is the more comfortable position.

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(1) E. **Vogt**, Zwickau. Experiments in Short Wave Therapy in Gynaecology especially in the treatment of tumours of the adnexa. Strahlentherapie 1936, No. 1.

If pliable electrodes are used the one under the back should be placed at a greater skin distance than the anterior one over the abdomen as, owing to the pressure of the patient's body the heat effect on the back will result in heat insulation and also interfere

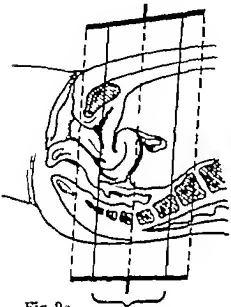


Fig 95

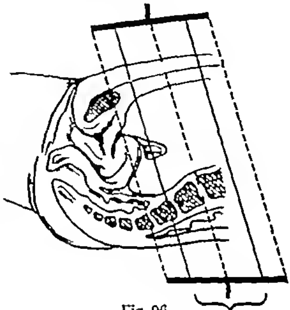


Fig 96

Fig 95

This shows the arrangement of the electrodes for transverse or lateral penetration of the uterus and adnexa according to Kowarschik

Fig 96

The electrode is so placed that the uterus and adnexa are lying beyond the most effective field zone

with free circulation so that the dosage and depth effect would be reduced if the posterior electrode were too small Pliable electrodes are not recommended here The electrode skin distances must be chosen so as to give even heat under both electrodes or a slightly increased heat under the abdominal electrode

## 15 Abdominal conditions.

According to Schliephake gastric diseases react well and good results are obtained by the treatment of chronic catarrh of stomach and the colon Réchou succeeded in curing cases of

Periduodenitis Haas and Loeb report a cure of peritonitis and appendicitis with a tendency to perforation Pain of many years duration from chronic peritonitis is alleviated and several varieties of liver troublo uninfluenced by any other method of treatment, respond well to treatment in the Short Wave field. Schliephake describes such a case in which good results were obtained with a 6 metre wave whereas a 12 metre wave proved quite ineffectual

Rapid improvement and recovery may be obtained in cholecystitis It is also advisable, if possible, to give a few Short Wave treatments before operations for gall stones

Gastric ulcers and periduodonitis have shown very good results especially in cases where there is a good deal of calcification Cases of ulcus ventriculi show very varying results according to Mahlo who has a large experience in this branch of work According to this writer penetration by short wave therapy results in increased peristaltis and affects the gastric juice so that the hydrochloric acid is reduced and an alkaline reaction obtained

**Technique of Treatment.** Treatment of the abdomen from back to front is the rule with Schliephake electrodes at skin distance of 5 to 7 cms

## *16 Diseases of the cardio-vascular system*

In many inflammatory and degenerative diseases of the myocardium there has been marked improvement or recovery as shown by the electrocardiograms. Schliephake reports alleviation in Angina Pectoris with much decreased frequency of attacks Among his cases is one important one where the symptoms in a case of Syphilis cleared up rapidly

**Arterial Hypertension.** Here treatment of the whole body is best although the blood pressure is only lowered to a slight degree In some cases penetration of the head itself with a wave length of 4.5 metres brought about lowering of the blood pressure Advanced arterial sclerosis does not react to short wave but good effects are got in the pre sclerotic stages This holds good for apoplectic attacks Last and Réchon got results in Raynaud's Gangrene and Dau et great improvement in Acro Cyanosis

According to Bürkmann short waves are efficient in *frost bite*, which is improved and even cured.

**Technic of Treatment.** The treatment of cardiac patients with short waves needs the same care and the same precautions that are necessary in all thermal treatment (moderate and individual dosage and control of pulse). Thorax treatment is done best with a Schliephake electrode of 18 cms diameter and wide spacing 8 to 7 cms.

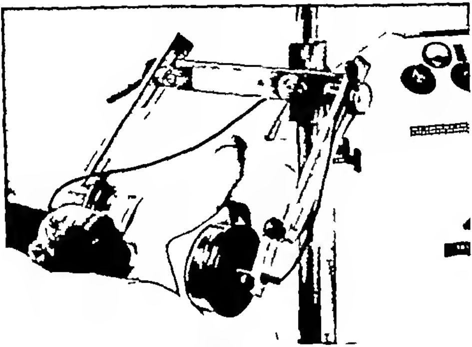

Fig 97

Treatment of thorax by Schliephake electrodes of 18 cms placed at skin distances of 4 to 7 cm. Patient in lateral position.

(Figs 97 and 98.) Pliable electrodes are inadvisable because of the strong surface heating. To avoid inconvenience to the patient by the heat it is well to remove all clothing from the upper part of the body.

In general disease pliable electrodes are not recommended as they produce more intense surface heating. Local treatment of the heart is best given on the bare skin to avoid complicated heat effect. When general treatment is given, the three plate method is indicated with large pliable electrodes at about 4 cm placed under the scapula, under the abdomen and under the calves as in Fig 99.

The electrode placed under the abdomen is connected to one pole of the apparatus the others connected by a bifurcated cable to the other In order to avoid energy losses, the couch should not be covered with leather, artificial leather or oilcloth

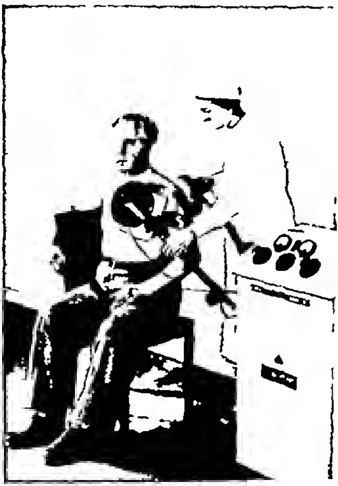

Fig 98.
Fig 98. The same with patient in sitting position

This method replaces the three plate method introdu  d in Long Wave Diathermy by Kowarschik This i however, not so good in Short Wave Therapy as in Diathermy

Undressing i unnecessary in these mild general treatment as the dosage applied i reduced and sweating does not occur a in electro-pyrexia.

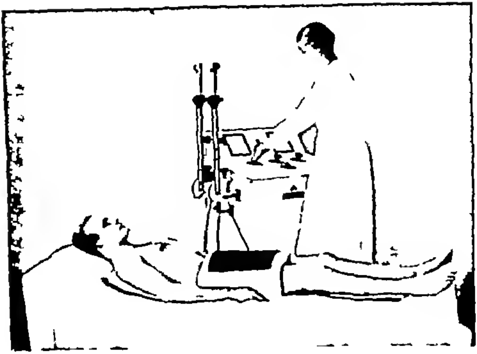

Fig 99

General Treatment Three plate method with three pliable electrodes of 30 × 20 cms diameter placed at distances up to 4 cms

## 17 Allergic and endocrine diseases

Migraine can be treated successfully Schliephake prefers wave lengths of 10 to 15 metre with low dosage producing merely a light sensation of heat Headaches due to angio pa m will disappear after one treatment of 10 minutes Weissenberg also reports complete relief of pain and symptoms even in chronic cases and severe attacks Huneke reports good and even surprisingly good results in migraine and other conditions by giving very short exposures by applying a normal dosage sufficient to cause a mild degree of heat for 1/2 minute with a wave length of 6 metres Using the Ultratherm a sensation of well being and vigour is obtained This method may have a contrary effect if treatment be prolonged over a certain time Treatment of the solar plexus and upper arm appears to have the same effect and Huneke considers that treatment time of 1/4 to 1 minute is ample here

Bronchial Asthma reacts very variously Some important cures are reported even of severe cases ([1]) According to Dousey diseases of the endocrine system can be cured by general treatment applying low dosage He reports recoveries after treatment of dystrophic adiposo genitalis and cyanosis of the extremities due to endocrine causes also in certain forms of alopecia and of mental retardation

Fig 100

Treatment of skull by Schliephake electrodes of 18 cm diameter and free air space of 3 to 6 cms.
The metal electrodes should be in contact with the bottom of the glass covers and the head fixed by a metal support at right angles or by some head support of insulating material.

**Technique of Treatment.** The three-plate method is best when giving treatment in small dosage

Fig 99 Mild treatment of the skull is also given with Schliephake electrodes of 16 cm and spacing of 6 cm using 6 metre wave length and 4 cm using 12 metre wave length

Fig 107 Spectacles should be removed to avoid field distortion

(1) Hun ke Krefeld. Relaxion in Therapy Fort br d. Med. 1935, Vol. 15.

## 18 Malignant tumours

No results have been obtained so far by a treatment of malignant tumours (carcinoma). Huwer reports unfavourable results (pain and increased growth). It is true that Reiter's experiments on inocculated rat tumours show that there are certain wave lengths that might eventually prove effectual but only the future can show whether these experiments can be made available for trial on the human body or whether other methods used in conjunction with Short Wave therapy, such as sensitisation by X Rays or combination with medical injections etc., would give more reliable results.

## 19 Lung diseases

Schliephake has obtained excellent results in the treatment of purulent diseases of the thorax (1). He has completely cured a number of patients suffering from severe diseases of pleural empyema which were unaffected by any other form of treatment so that the cases were regarded as hopeless.

All his patients suffering from severe empyema after pneumonia were afebrile and free from symptoms in 3 to 5 days. Dullness cleared up after two to three weeks and complete cure resulted after an average of 3 to 6 weeks of treatment. Complete cures have also resulted in all the cases treated by him of acute and chronic abscesses of the lung of varied aetiology and various usual mixed infections, some complicated with gangrene. In none of these was any malignant disease found. In most cases operative interferences can be avoided. In one case only of empyema with a mixed infection including tubercle bacillus puncture had been done to clear away the residual exudate. These good results have been confirmed by Liebesny, Flandin and others and are of great value as the literature gives a mortality in lung abscesses of 60 to 70 per cent without and 33 to 40 per cent with operation.

Schliephake and one other writer have obtained good results in treating pulmonary tuberculosis which has encouraged them to make further experiments in that direction. As yet however experience and results in the treatment of pulmonary tuberculosis are too few to justify any definite conclusion.

(1) Treatment by Short Electric Waves. Strahlentherapie 1935, No 5.

Exudative forms would appear to react best of all. In most of these cases focal reaction and some increase of rhonchi and rales are sometimes observed after Short Wave treatment but these steadily decrease. Remarkable is the fact that no really bad results of Short Wave treatment of pulmonary tuberculosis have so far been observed by any writer. This is contrary to the experience obtained in Long Wave diathermy which tends to activate the tubercular process to an even dangerous extent.

Very good results have been obtained in non tubercular diseases. For instance, in severe infiltration of the lung following Malta fever and even in bronchiectasis provided the cases were not too advanced. Also in many cases of pneumonia and pleurisy and in acute and chronic bronchitis.

As to asthma, there are some excellent results. Some cases however are entirely refractory to Short Wave therapy, evidently the aetiology is of great importance here.

**Technique of Treatment in Lung Conditions.** As a rule electrodes enabling air distance and spacing are the most suitable here as owing to the thickness of the thorax and the fairly deep-seated position of the affected organs large skin distances must be arranged for. In the majority of lung diseases treated by him, Schliephake used wave lengths of 6 to 15 metres, adjusting his dosage to each individual case. Special attention must be paid to spacing which should be sufficiently large. In his manual on Short Wave Therapy Schliephake publishes a number of excellent X Ray pictures clearly showing the course and result of treatment (1).

In all these cases treatment can be given either in the recumbent or lateral position — Figs. 97 and 98. If a treatment table is used, it can also be carried out in the supine position.

## 20 Treatment of renal diseases

Good satisfactory and a few unsatisfactory results have been reported in this field by Schweitzer, Foss, Rausch and others. Rapid cures have taken place in the treatment of acute and chronic pyelitis. In cases of chronic pyelitis with fever and tendency to

(1) O. Schedtler: Therapy of Short Electrical Waves especially in Tubercular Diseases. Beiträge Klin. Tbk. 86, H. 4.

relapse the temperature went down rapidly and the purulence became much less, also decrease of leucocytes and bacteria was marked.

Mahlo succeeded in making a rapid cure of a man of 72 suffering with a severe renal abscess. Schliephake reports the cure of a para nephritic abscess with fistulae.

**Technique of Treatment.** Treatment is given by electrodes applied vertically or at right angles, one on the dorsum over the kidney and the other of larger size over the abdomen. The latter should have a larger skin distance of 4 to 6 cms., as the exact anatomic position of the kidneys cannot always be accurately determined. The electrodes must be of such a size that the Ultra Short High Frequency current will pass through a field large enough to ensure complete penetration of the kidney. Rausch recommends long exposures of two hours in these renal treatments and very careful medical supervision as regards general condition and metabolic change.

# X. Resumée.

A study of this publication will certainly show that two conditions must be fulfilled in order to get the best possible results in Short Wave Therapy

1) A thorough knowledge of the method and technique.
2) Efficient apparatus

As regards the method of Technique of Treatment to be applied (electrodes, skin distances, type of apparatus, valve or spark gap equipment), we set ourselves the task of enabling the practitioner to form a well-founded opinion on the matter. To enable him to do that, we referred to the experience given hitherto in the special literature on this subject (See Manual of Publication.) We have limited the chapters concerning the indications for Short Wave treatment and the results obtained therefrom to the absolute necessary. We have made use here of the most important reports and information given by physicians on the experience they have gained in practice. We would like to express our thanks for their cordial collaboration.

First of all we are indebted to Dr. Schliephake who gave us, as regards the medical part of this manual, much good advice based on his successful short wave practice of the last seven year.

We see the indication range of short wave therapy large and it is already growing steadily with the further development of this method of treatment. Consequently we must aim in future at a still more sharply defined conception of the field of indication and a more [illegible] method for each condition.

The constantly growing literature on this subject and the extraordinarily rapid development of Short Wave Therapy prove that we [illegible] lines. Doubtless the results obtained hitherto already [illegible] right of existence for this great method of therapy and [illegible] appropriate means for healing the sick, for raising [illegible] public health and for increasing the working capacity [illegible]

## *Supplement to page 70*

### Temperature Measurement during Short Wave Penetration

In the Siemens Reiniger Werke Paetzold has done experiments with several kinds of thermometers for verifying their use in measuring the dosage in Short Wave Therapy These experiments included mercury filled glass thermometers with coloured alcohol also quartz glass thermometers with chemically pure benzole The alcohol thermometers have proved useless owing to the alcohol being heated up to a high degree Mercury thermometers are useful in some cases that is the indications are practically sufficiently exact if the thermometers are surrounded by substances of high dielectric constant and provided the mercury column is vertical to the field line direction When carrying out measurements in free air spaces, i e., between the skin and the electrode the errors due to field concentration caused by the glass are beyond the limit allowed in practice (dielectric constant of air = 1 of glass = 5 to 7)

The measuring results obtained with quartz benzole thermometers have been sufficiently accurate, as the field concentration in air by the quartz is essentially decreased as compared with glass (dielectric constant of quartz = 3 7) The investigation have resulted in the construction of a quartz thermometer with flat lens shaped benzole vessel enabling a good contact with the skin to be obtained. Experiments made on patients show that the thermometer renders excellent service especially when the heat feeling of the patient is disturbed

# Index

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